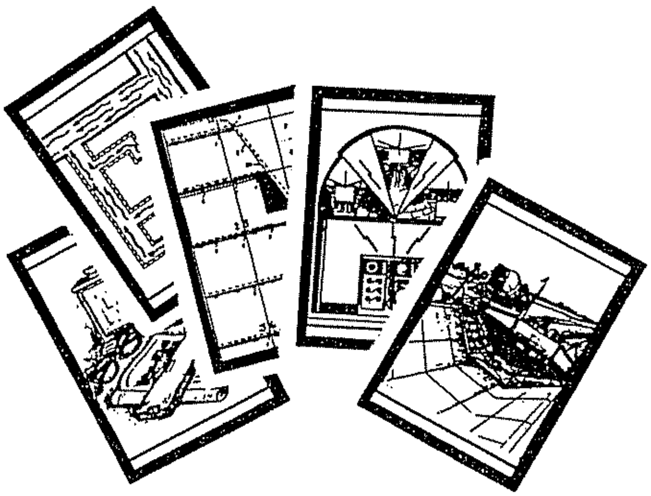
21-7

WATER CONSERVATION OPPORTUNITIES
IMPERIAL IRRIGATION DISTRICT, CALIFORNIA



SPECIAL REPORT

July 1984

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Robert A. Olson, Acting Commissioner
N. W. Plummer, Regional Director
Lower Colorado Region

WATER CONSERVATION OPPORTUNITIES

IMPERIAL IRRIGATION DISTRICT, CALIFORNIA

SPECIAL REPORT

July 1984

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Robert A. Olson, Acting Commissioner
N. W. Plummer, Regional Director
Lower Colorado Region

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

Nothing in this study is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona v. California, et al. (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501).

This report was prepared pursuant to the Federal Reclamation Act of June 17, 1902. Publication of the findings and recommendations herein should not be construed as representing either the approval or disapproval of the Secretary of the Interior. This report summarizes studies and results to date and provides a reference when further studies are undertaken.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

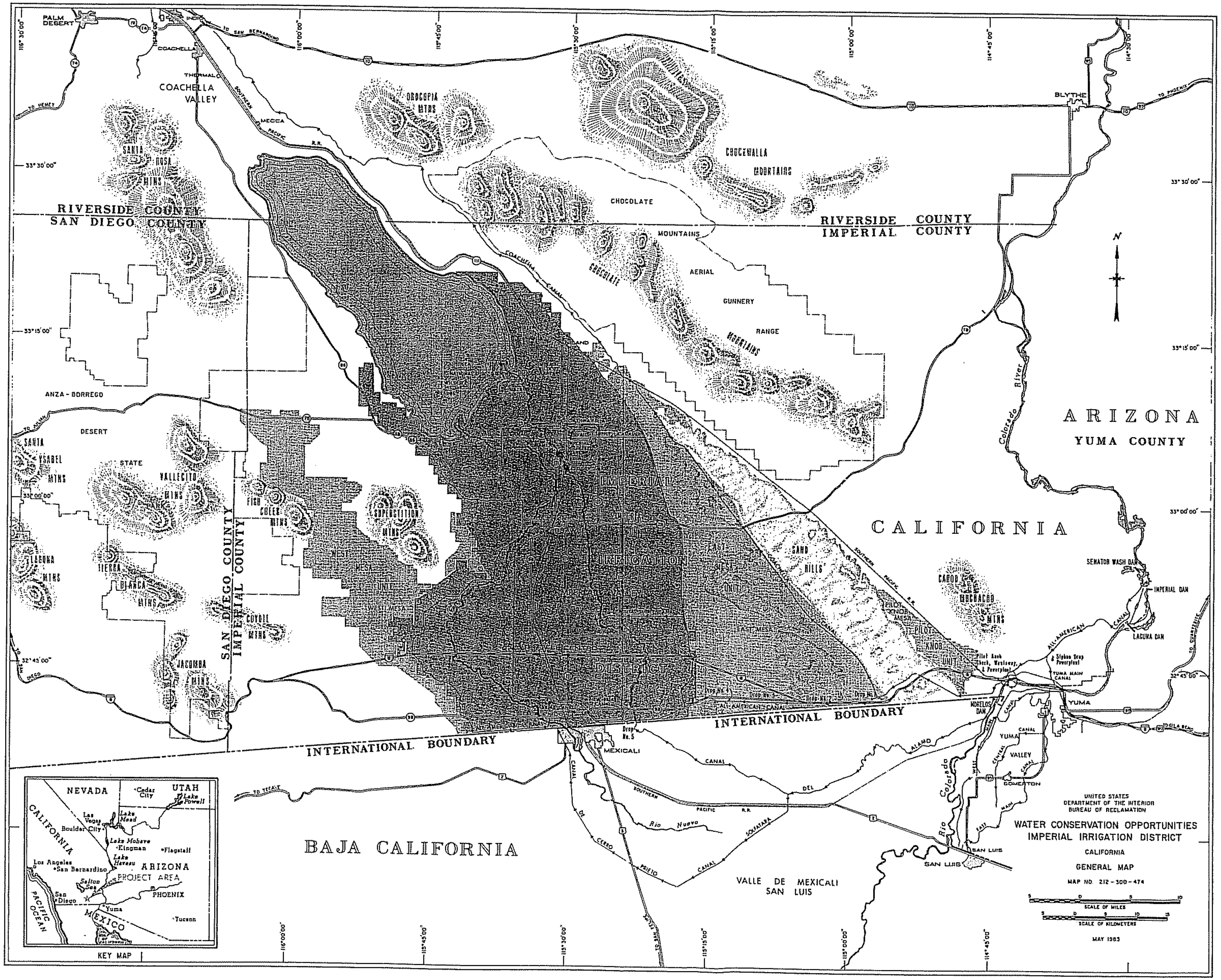
LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF DRAWINGS

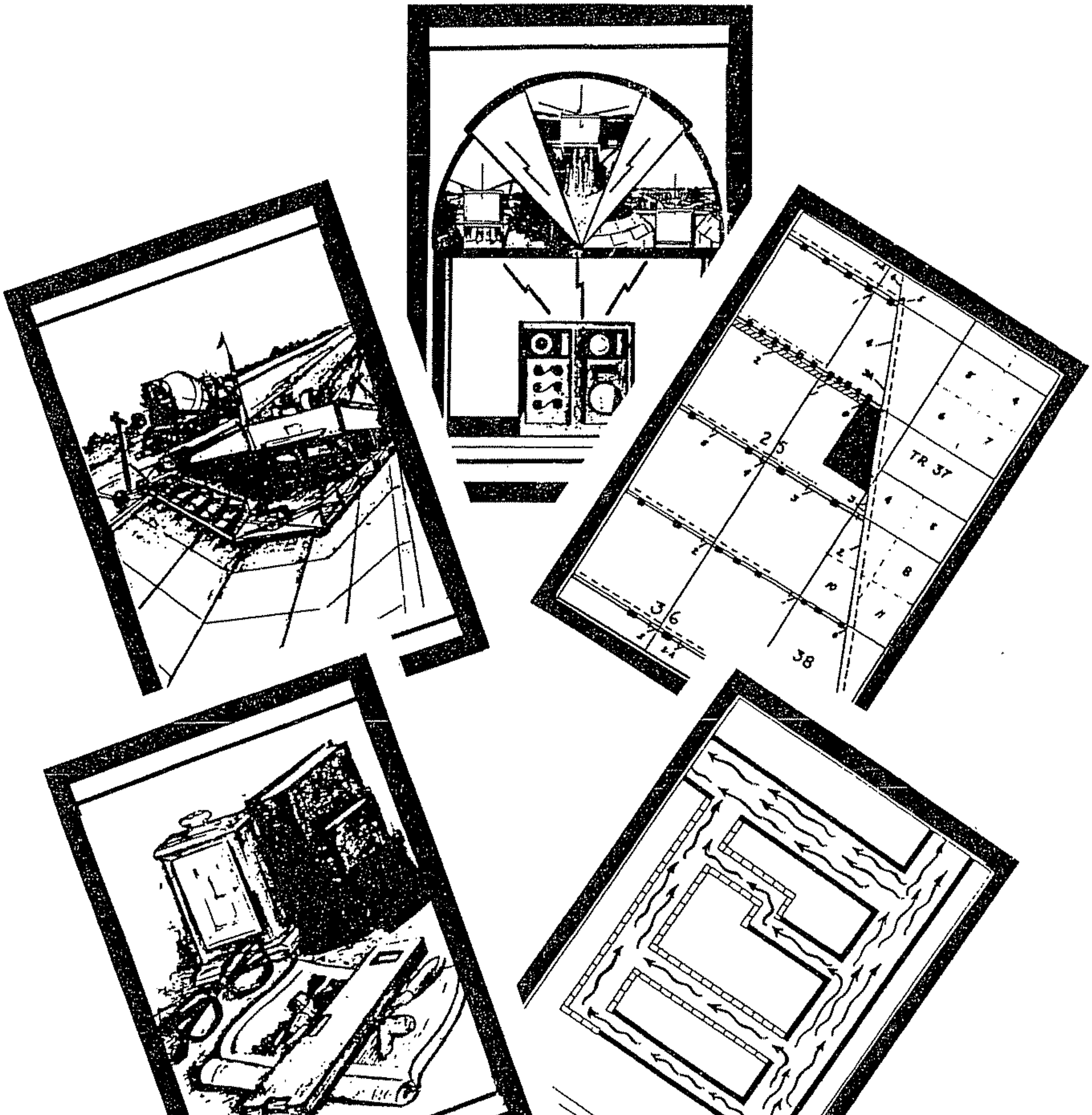
LIST OF FIGURES

APPENDED MATERIAL



PALM DESERT
COACHELLA
THERMAL
COACHELLA VALLEY
MECCA
OROCOPIA MTNS
CHUCKWALLA MOUNTAINS
BLYTHE
SANTA ROSA MTNS
RIVERSIDE COUNTY
SAN DIEGO COUNTY
RIVERSIDE COUNTY
IMPERIAL COUNTY
CHOCOLATE MOUNTAINS
CHOCOLATE MOUNTAINS
AERIAL GUNNERY RANGE
COACHELLA CANAL
ANZA-BORREGO DESERT STATE
VALLECITO MTNS
FISH CREEK MTNS
SUPERSTITION MTNS
IMPERIAL IRRIGATION DISTRICT
SAND HILLS
ARIZONA
YUMA COUNTY
CALIFORNIA
Colorado River
SENATOR WASH DAM
IMPERIAL DAM
LAGUNA DAM
CARGO MUCHACHO MTNS
ALL-AMERICAN CANAL
YUMA
SAN DIEGO COUNTY
IMPERIAL COUNTY
COYOTE MTNS
JACUMBA MTNS
LAGUNA MTNS
INTERNATIONAL BOUNDARY
INTERNATIONAL BOUNDARY
MEXICALI
YUMA VALLEY
SOMERTON
SAN LUIS
BAJA CALIFORNIA
VALLE DE MEXICALI SAN LUIS
Rio Nuevo
Colorado Rio
NEVADA
UTAH
CALIFORNIA
ARIZONA
PROJECT AREA
PHOENIX
PACIFIC OCEAN
MEXICO
KEY MAP
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WATER CONSERVATION OPPORTUNITIES
IMPERIAL IRRIGATION DISTRICT
CALIFORNIA
GENERAL MAP
MAP NO. 212-300-474
SCALE OF MILES
SCALE OF KILOMETERS
MAY 1983

EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

WATER CONSERVATION OPPORTUNITIES
IMPERIAL IRRIGATION DISTRICT, CALIFORNIA

SPECIAL REPORT

LOCATION AND SETTING: The Imperial Irrigation District (District) is located in Imperial County, California as shown on Frontispiece Map No. 212-300-474. El Centro, the largest city in the county and the county seat, is located in the southwestern portion of the District about 60 miles west of Yuma, Arizona, and about 120 miles east of San Diego, California. Brawley, the second largest city in the county, is located in the north central portion of the District about 14 miles north of El Centro. The District itself is bounded on the east by the Cargo Muchacho Mountains and the Chocolate Mountains; on the northeast and north by the Chocolate Mountains and the Chocolate Mountains Aerial Gunnery Range; on the northwest by the Salton Sea; on the west by the Superstition, Fish Creek, Vallecito, Coyote, and Jacumba Mountains; and on the south by the International Boundary with Mexico.

The District's irrigation service area of 1,062,290 acres is divided into the East Mesa, Imperial, Pilot Knob, and West Mesa Units as shown on the Frontispiece Map. Only the Imperial Unit has been developed due to the lack of adequate water supplies. About 458,000 acres of the 694,400 acres in the unit are irrigated.

As of December 31, 1981, the District operated and maintained the headworks, desilting basins, and California Sluiceway at Imperial Dam; the Check and Wasteway at Pilot Knob; the 80-mile All-American Canal; 1,625 miles of main canals and laterals, of which about 840 miles have been concrete-lined by the District; four small regulating reservoirs; all associated diversion and control structures; and Senator Wash Dam and Reservoir.

About 2.7 million acre-feet of Colorado River water are diverted at Drop No. 1 to the District annually. The annual mean daily flow is about 4,000 cubic feet per second (cfs), but normal summertime flows are about 6,000 cfs. All District return flows, which amount to about 912,000 acre-feet per year, eventually enter the saline Salton Sea (Sea).

PURPOSE AND AUTHORITY FOR REPORT: The purposes of this special report are to identify areas of potential water savings in the District, to determine whether future detailed studies that could lead to recommendations for Bureau of Reclamation (Reclamation) project development are justified, to identify other opportunities that the District and irrigators could consider, and to document completed activities. Alternative structural and nonstructural water conservation measures were evaluated considering existing District irrigation facilities, operations, and practices to determine the potential for conserving water currently entering the Sea. Conserved water would be used to develop an additional water supply to meet future water need in the District and in southern California.

Approximately $988,000 have been expended for the 4-year special study which began in 1980. Federal and non-Federal expenditures for the study are as follows:

Federal Funding	
Federal Activities	$725,000
Contracted District services to gather discharge measurement data	113,000
District inkind services to operate the demonstration onfarm water management program	125,000
Other agency inkind services	25,000
Total	$988,000

Authorization and funding for detailed investigations have been recommended for those features exhibiting potential for water conservation. Detailed feasibility study authority is under consideration by the 98th Congress in S. 622 which has been supported by the District and the Colorado River Board of California. Investigations will determine if a recommendation should be made to Congress for the authorization and construction of any required facilities.

This report is submitted in compliance with instructions contained in the Federal Reclamation Act of June 17, 1902 (Public Law 161, 32 Stat. 388) and in acts amendatory thereof or supplementary thereto.

PROBLEMS AND OPPORTUNITIES: The following problems and opportunities were identified during the investigation.

Problems

° Colorado River flows are inadequate to meet future agricultural and municipal and industrial (M&I) needs in southern California. Up to 910,000 acre-feet per year of additional M&I water could be required in southern California by the year 2000.

- Spills to the drainage system, seepage from canals and laterals, and fluctuating deliveries to the growers result because the 1,600-mile distribution system lacks adequate facilities to maximize operating efficiency and assure a full water supply to crops.

- Approximately 912,000 acre-feet of District agricultural return flows enter the Sea annually where they mix with the highly saline water in the Sea and are not available for additional beneficial consumptive use by agriculture, industry, or municipalities.

- The travel time from the source of supply at Parker Dam to the District results in releases to the District, based on anticipated needs, that sometimes are either insufficient or exceed actual needs. Approximately 28,000 acre-feet of District water per year have been discharged directly to Mexico in excess of Mexico's annual allotment, or discharged directly to the Sea.

- Significant capital expenditures will be necessary to accomplish canal lining of the larger capacity canals and to provide other possible structural measures capable of conserving water.

- Substantial and effective demonstration programs and gradual use of system scheduling and other measures will be required to assure growers that a full water supply can be delivered while accomplishing water conservation.

- Excess tailwater spills; deep percolation; lower yields; and higher labor, water, and fertilizer costs result from fluctuating deliveries to fields, improper application of water, and poor timing of irrigation events.

- The elevation of the Sea has historically fluctuated and has been rising. ,Extensive study has been conducted on methods to stabilize water levels and salinity. Agricultural lands, residential and recreational property, and wildlife refuges have been inundated by rising water levels. Water conservation may significantly affect water levels and salinity. Potential impacts on land use, wildlife habitat, fisheries, and recreation must be carefully evaluated. Trade-offs will likely be necessary.

Opportunities

- To make additional water available to meet future agricultural and M&I needs in southern California through water conservation.

- To identify practical conservation measures having high degrees of confidence for yielding predictable annual increments of new water to meet future agricultural and M&I needs in southern California.

- To assure water delivery to the farmer at the time and in the amount needed.

- To schedule water delivery to the District based upon actual rather than anticipated need so that release of unneeded water from Parker Dam will be minimized.

- To develop programs and services to inform growers on crop water requirements, timing for water applications, and successful new water application techniques.

- To provide information and incentive programs to encourage onfarm water conservation.

- To minimize District return flow entering the Sea.

LOCAL CONSERVATION ACTIVITIES: A summary of District-sponsored conservation activities is displayed in Table 1.

WATER CONSERVATION OPPORTUNITIES: Even though the irrigation system in the District was constructed in the early 1900's, it operates as or more efficiently as neighboring irrigation projects. Even so, the special study identifies cost-effective water conservation opportunities in the District. Additional studies have been recommended to investigate these opportunities in more detail.

Conservation opportunities include both structural features and management techniques that warrant more detailed study. These opportunities fall into four major groups: (1) structural measures modernizing the distribution system which have predictable and measurable effectiveness; (2) structural measures whose effectiveness may diminish with the implementation of Group 1 features or successful distribution system and onfarm management programs; (3) distribution system management programs; and (4) onfarm management programs. Table 2 compares the water conservation features evaluated during the investigation. Some of the management programs included in the table were not evaluated, but may deserve detailed analysis or demonstration during the Canal Lining and System Improvement Study.

Predictability of effective water conservation results varies with the different features. Uncertainties associated with Group 1 features are minimal since results are predictable and measurable. These features

Table 1
DISTRICT-SPONSORED CONSERVATION ACTIVITIES
Water Conservation Opportunities
Imperial Irrigation District, California

- Canal Lining Program - 840 miles have been lined through a voluntary District/landowner cost-sharing program.

- Reservoir Regulation Program - four 500 acre-foot reservoirs have been constructed at main canal drops at a cost of about $1 million each. Up to 12 additional sites are being considered for development.

- Selective System Automation - a system of 23 remote-controlled gates and 17 float-controlled gates has been installed on main canals to improve operational efficiency.

- Canal Seepage Recovery System - a system of collector drains and sump pumps has been installed along sections of the All-American Canal and the East Highline Canal to recover canal seepage.

- Board of Directors conservation initiatives:

  1976 - A 13-point program for water conservation and system improvement was adopted.

  1977 - A 5-year cooperative irrigation efficiency study was initiated with the Brawley Research Center of the U.S. Department of Agriculture.

  1979 - A Water Conservation Advisory Board composed of District farmers was created to advise the Board of Directors on conservation matters.

  1980 - A 21-point program of more stringent conservation policies and procedures was adopted.

  1980 - A water rate increase to fund an expanded water conservation program was adopted.

  1981 - A 2-year water management and conservation demonstration program was initiated. A water conservation supervisor and three technicians were hired to operate the program.

  1981 - The annual budget was increased for the canal lining program and for accelerated regulating reservoir construction.

Table 2
COMPARISON OF WATER CONSERVATION FEATURES
Water Conservation Opportunities
Imperial Irrigation District, California

Feature	Potential Water Conservation (acre-feet)	Capital Cost ($ Million)	Annual Cost ($/acre-foot) 1/ Ammortization Period (20 Yrs)	Annual Cost ($/acre-foot) 1/ Ammortization Period (40 Yrs)	Further Study Period (Years)	Potential Implementation Period (Years)	Responsible Agency 2/	Relative Degree of Certainty of Results
1. Structural features unaffected by operational changes:								
Canal Lining (340 mi.)	104,000	74	73	60	2-5	5-10	Fed/Partner	High
System Automation-East Highline Canal Only	25,000	8.5	35	29	3-5	5-10	Fed/Partner	High
Onfarm Water Measuring Devices	-------	4.5	--	--	1-5	5-10	Fed/Partner	Unknown 3/
Sub total	129,000	87.0	69	57				
2. Structural features possibly affected by operational changes:								
Large Regulating Reservoir	20,000	24.4	125	104	4-5	5-15	Fed/Partner	High (Initial) Moderate (Long Term) 4/
Spill Interceptor System (no right-of-way cost incl.)	70,000	13	19	16	4-5	5-15	Fed/Partner	High (Initial) Low (Long Term) 5/
Sub total	90,000	37.4	43	35				
3. Distribution system management programs:								
Computerized Delivery System Scheduling	------	.3	--	--	2-5	5-20	District/Fed	Unknown 6/
Administrative Programs	------	----	--	--	5	5-20	District/Irrigator	Unknown 7/
Sub total		.3						
4. Onfarm management programs:								
Field Scheduling	135,000	.5	19 8/	19 8/	5+	20+	Irrigators/District	Low 9/
Administrative Information and Incentive Programs	-------	-----	--	--	5+	20+	District/Irrigators	Unknown 10/
Sub total	135,000	.5	19	19				
Total	354,000	124.9 11/	43 8/	37 8/				

1/ Capital costs are amortized at 8.125 percent and include interest during construction for equal annual expenditures.

2/ District and other beneficiaries of conserved water willing to finance cost of conservation measures.

3/ More precise measurement of farm deliveries is essential to improved conservation, but actual savings would be difficult to assess.

4/ Potential source of water conserved could be reduced through the implementation of system scheduling and more precise water ordering. However, improved operational flexibility provided by the reservoir may compensate by reducing operational spills elsewhere in the system.

5/ Features such as system automation, regulating reservoirs, and system scheduling could significantly reduce the spills that would be collected by the spill interceptor system.

6/ Computerized delivery system scheduling can improve operating efficiency, but the impacts of a computerized delivery system scheduling program are difficult to assess without a 2- to 3-year demonstration program.

7/ Would include a modified demand operation, information programs, and changes in policy. However, the effectiveness of these administrative programs could not be assessed without a multi-year demonstration program.

8/ Would include annual operating costs of $2.5 million for providing field irrigation scheduling.

9/ The ultimate impacts are unknown because success requires full implementation and use by water users. Full implementation may not be possible and maximum implementation may require up to 20 years. The ultimate level of implementation will depend on the effectiveness of the ongoing WMC demonstration program.

10/ These programs would require a multi-year demonstration period in order to assess their impacts on conservation.

11/ Excludes capital costs for Feature 3. Computerized delivery system scheduling operational costs would total an additional $500,000 annually for 450,000 acres served.

display technical feasibility and can be implemented in a finite time frame, depending upon capital funding availability. Uncertainties associated with Group 2 features are higher because the technical and operational uncertainties are greater. The useful life of these features could be shortened, or yields significantly reduced, by implementation of other distribution system management programs and, possibly, by construction of other system improvements. Group 2 features may eventually become unneeded or infeasible.

Even though distribution system and onfarm management programs appear to be some of the most productive and cost effective measures, the greatest degree of uncertainty is associated with these measures because: (1) the onfarm measures cannot be fully effective unless the distribution system is capable of delivering a specified amount of water at the time it is needed, and (2) these measures rely upon widespread effective information dissemination and effective voluntary adoption and use by system operators and water users.

Initial consideration of further detailed study leading to authorization and funding of water conservation program implementation would concentrate initially on those Group 1 features producing the most predictable results. Implementation of the other features would follow over a several-year period. Activities during the first 3 to 5 years could include lining the canals, installing the automated control system on the East Highline Canal, and installing water measuring devices on all customer turnouts. A computerized system scheduling program could also be initiated as a demonstration program in one of the division offices. Administrative programs to inform and encourage conservation through incentives that could be tested as part of the demonstration could continue and expand as the program gains acceptability with the farmers.

The second phase of the water conservation program extending over the next 5 to 10 years could include construction of Group 2 features, including the large regulating reservoir adjacent to the All-American Canal and the spill interceptor system, provided these features are still needed and feasible. The system scheduling and onfarm water management demonstration programs could be expected to continue and expand.

Finally, the third and fourth phases could concentrate on Group 3 and Group 4 features including District-wide implementation of system scheduling and onfarm management programs. These last phases could take several more years depending upon how quickly system operators and growers adopt the programs.

Subsequent to reviewing study results with Reclamation planners, the District stated, by letter dated April 10, 1984, its desire to participate with Reclamation on a 50/50 cost-sharing basis in the Canal Lining and System Improvement Study (CLSIS). The CLSIS is scheduled to begin in the fall of 1984. The letter also specified the District's priorities in the following order:

1. East Highline Canal lining and system automation

2. 8,000 acre-foot regulating reservoir

3. Lining of other main canals and construction of other regulating reservoirs

4. Interceptor system

5. Onfarm management (voluntary).

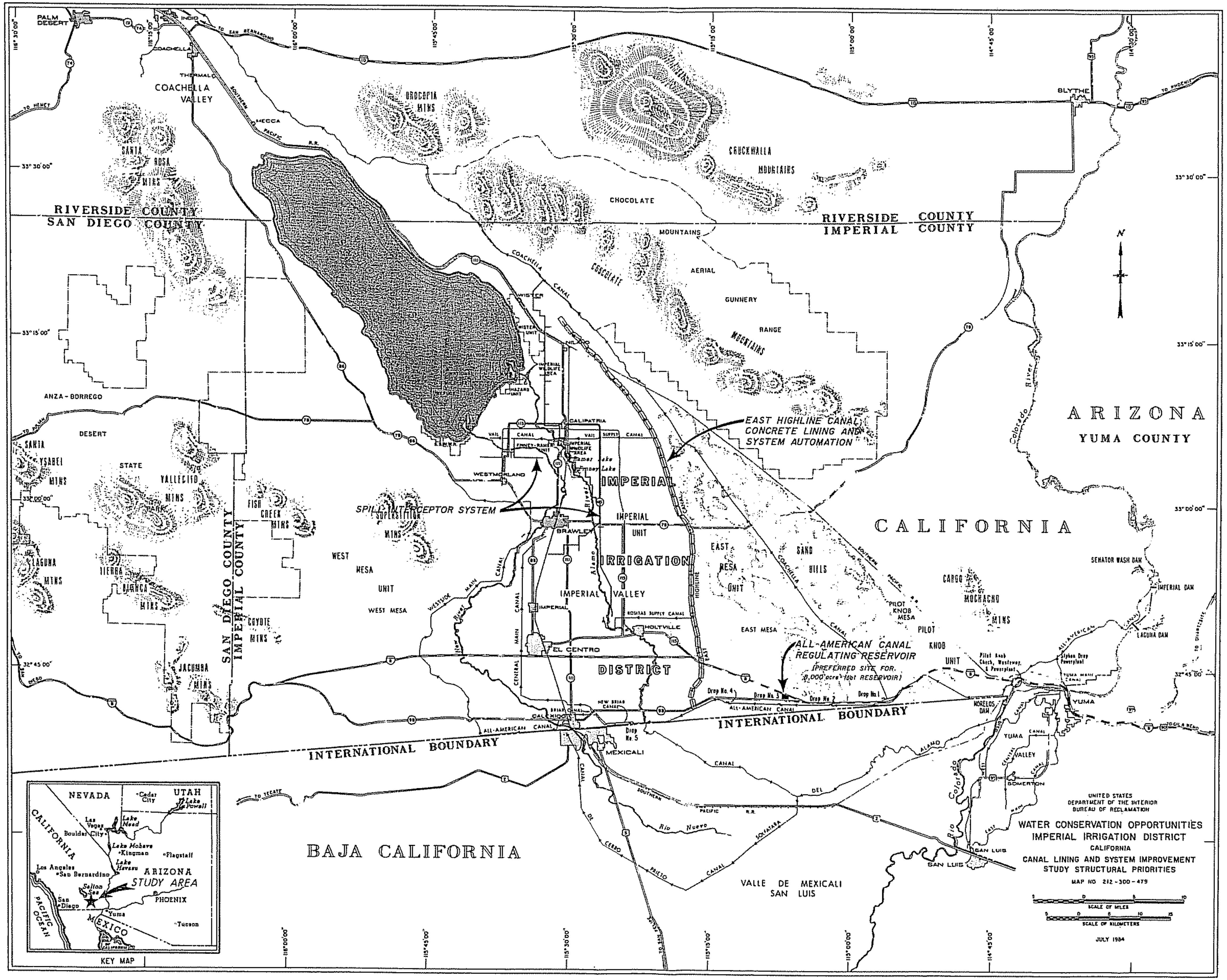
The District would like to expedite the study of: East Highline Canal lining and system automation and the 8,000 acre-foot regulating reservoir. The District would like to complete this portion of the study within two years. The other items could be accomplished subsequently during the period of study. The CLSIS will accommodate District priorities as closely as practical. Drawing No. 212-300-479 shows the locations of the structural priorities which will be addressed by the CLSIS.

Work on the East Highline Canal is given the highest priority due to the greatest potential of yielding the largest block of conserved water with the highest degree of certainty. The work on the regulating reservoir is also given a high priority even though the effectiveness of the reservoir in conserving the water spilled to Mexico could be reduced in the future. The improved operational flexibility provided by the reservoir could reduce spills elsewhere in the delivery system and could compensate for the possible reduced future need to conserve the water spilled to Mexico.

The lining of other main canals and construction of other regulating reservoirs is third in priority since the District plans to continue with its ongoing canal lining and small regulating reservoir programs. Some of the objectives of these programs include improved response time of water deliveries, conveyance system water regulation, operational flexibility, and reduced maintenance.

IMPACTS OF CONSERVATION ON SALTON SEA: A Salton Sea modeling study was conducted to project future elevations and salinities under current conditions and with implementation of a water conservation program. Projections of continuing current trends indicate elevations will stabilize somewhat fluctuating between -233 feet and -229 feet below mean sea level. Projected elevations would decline with implementation of the conservation program to a lower elevation of about -245 feet occurring about 15 years after full implementation of the program. Elevations would then continue to fluctuate between -241 feet and -247 feet depending on natural runoff.

With a continuation of current conditions, projected salinity would reach about 79,000 milligrams per liter (mg/L) by the year 2030. The projected salinity occurring with the proposed conservation program would

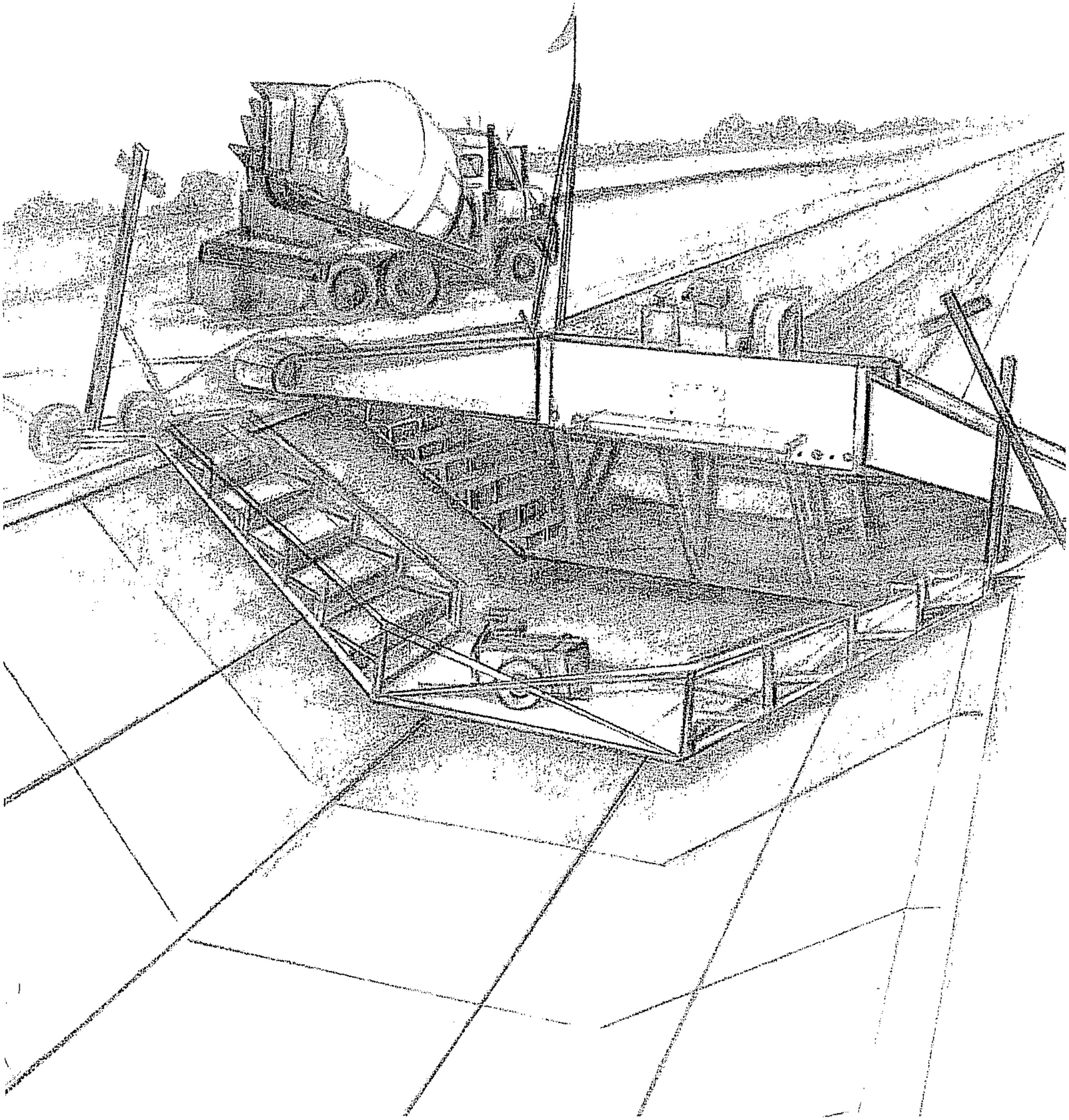


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WATER CONSERVATION OPPORTUNITIES
IMPERIAL IRRIGATION DISTRICT
CALIFORNIA
CANAL LINING AND SYSTEM IMPROVEMENT
STUDY STRUCTURAL PRIORITIES
MAP NO 212-300-479
SCALE OF MILES
SCALE OF KILOMETERS
JULY 1984
EAST HIGHLINE CANAL CONCRETE LINING AND SYSTEM AUTOMATION
SPILL INTERCEPTOR SYSTEM
ALL-AMERICAN CANAL REGULATING RESERVOIR
(PREFERRED SITE FOR 8,000 acre-foot RESERVOIR)
IMPERIAL IRRIGATION DISTRICT
IMPERIAL VALLEY
RIVERSIDE COUNTY
SAN DIEGO COUNTY
IMPERIAL COUNTY
ARIZONA
YUMA COUNTY
CALIFORNIA
BAJA CALIFORNIA
INTERNATIONAL BOUNDARY
COACHELLA VALLEY
CHOCOLATE MOUNTAINS
AERIAL GUNNERY RANGE
CHUCKWALLA MOUNTAINS
OROCOPIA MTNS
SANTA ROSA MTNS
ANZA-BORREGO DESERT STATE PARK
WEST MESA UNIT
EAST MESA UNIT
PILOT KNOB MESA
PILOT KNOB UNIT
SAND HILLS
CARGO MUCHACHO MTNS
BRAWLEY
EL CENTRO
CALEXICO
MEXICALI
HOLTVILLE
CALIPATRIA
WESTMORLAND
YUMA
SOMERTON
SAN LUIS
BLYTHE
PALM DESERT
INDIO
COACHELLA
VALLE DE MEXICALI
SAN LUIS
KEY MAP
NEVADA
UTAH
CALIFORNIA
ARIZONA
STUDY AREA
MEXICO
PACIFIC OCEAN

be about 136,000 mg/L in the year 2012. Beyond the year 2012, the salinity will increase, but at a much slower rate than expected during the period of conservation implementation.

Impacts evaluated by this study probably represent the most severe case. Rates of decline in Sea elevation and increases in salinity concentrations will be proportionally less if only a portion of the conservation program is implemented or if the conservation program is implemented at a slower rate than anticipated. However, a more detailed analysis of Sea impacts should be included in future studies leading to the authorization and funding of water conservation programs.

INTRODUCTION



I. INTRODUCTION

A. Purpose and Scope

The purposes of this special report are to identify areas of potential water savings in the Imperial Irrigation District (District), to determine whether future detailed studies that could lead to recommendations for Bureau of Reclamation (Reclamation) project development are justified, to identify other opportunities that the District and irrigators could consider, and to document completed activities. The application of structural and nonstructural water conservation measures to existing District irrigation facilities, operations, and practices in promoting more efficient use of water is assessed. Conserved water would be used to develop an additional water supply to meet future water needs in the District and in southern California. Water conservation measures include: (1) canal lining; (2) spill interception; (3) reservoir regulation; (4) system automation; (5) distribution system management programs; and (6) onfarm water management programs. Congress appropriated funds to begin this special report in fiscal year 1980.

Authorization and funding for feasibility investigations will be recommended for those features exhibiting potential for water salvage or conservation. Feasibility investigations will determine if a recommendation should be made to Congress for the authorization and construction of any required facilities. The District would retain title to any water made available through the implementation of a water conservation measure.

B. Authority for Report

This report is submitted in compliance with instructions contained in the Federal Reclamation Act of June 17, 1902 (Public Law 161, 32 Stat. 388) and in acts amendatory thereof or supplementary thereto. Supplementary acts include the Colorado River Basin Salinity Control Act of June 24, 1974 (Public Law 93-320, 88 Stat. 266), the Emergency Drought Act of April 7, 1977 (Public Law 95-18, 91 Stat. 36), and the Appropriations Act of September 4, 1980 (Public Law 96-336, 94 Stat. 1063).

C. Previous Investigations and Reports

The following reports indicate that a potential for water conservation exists in the District. These various reports indicate that up to 438,000 acre-feet of water could be saved annually through the implementation of all suggested conservation measures:

° Report on the Water Conservation Opportunities Study. United States Department of the Interior, Bureau of Reclamation and Bureau of Indian Affairs. September 1978.

° Investigation Under California Water Code Section 275 of Use of Water by Imperial Irrigation District. State of California, The Resources Agency, Department of Water Resources, Southern District. December 1981.

° Trading Conservation Investments for Water. Environmental Defense Fund, Environmental Defense Fund, Inc. March 1983.

A listing of referenced reports and documents is appended.

D. Current Related Investigations

The Division of Planning, Lower Colorado Regional Office, Bureau of Reclamation is conducting a number of related studies under the Lower Colorado River Water Conservation and Efficient Use Investigation. In addition to the Water Conservation Opportunities, Imperial Irrigation District Study, these other studies include water conservation opportunities in the Coachella Valley Water District, reduced evaporation on Lake Mead, and vegetative management on the Lower Virgin River.

In addition to the water conservation opportunities studies, the All-American Canal Relocation Study will determine the feasibility of constructing a new 30-mile concrete-lined section of the All-American Canal. The new canal section would save an estimated 70,000 acre-feet of water currently being lost each year through seepage. The new canal section would be located adjacent to the existing unlined alinement between Pilot Knob and Drop No. 4.

Another related study, the Lower Colorado Water Supply Study, concerns the identification of recommended water supplies for users of Colorado River water in California who do not hold water rights or whose water rights are insufficient to meet their needs.

E. Public Involvement

Several planning meetings were conducted during the course of the investigation. The purpose of these meetings was to receive additional study input, to review the status of ongoing investigations, and to better coordinate overall study efforts. Representatives from various Federal and State agencies, the District, and other interested individuals and organizations attended. A listing of the pertinent public involvement activities conducted during the course of the investigation is appended.

F. Historical, Legal, and Institutional Background

The All-American Canal System was authorized by the Boulder Canyon Project Act of December 21, 1928 (Public Law 642, 45 Stat. 1057) to deliver Colorado River water to the Imperial and Coachella Valleys. The All-American Canal System was constructed by Reclamation between 1934 and 1940. The Coachella Canal was constructed between 1938 and 1948.

The first scheduled water delivery through the All-American Canal was received in the Imperial Valley in October 1940. By 1942, the entire water supply for the Imperial Valley was being received through the All-American Canal.

Operation and maintenance responsibilities for the All-American Canal below Pilot Knob Check, Wasteway, and Powerplant (Pilot Knob) (Station 1098) were transferred to the District on March 1, 1947. Operation and maintenance responsibilities for the All-American Canal above Pilot Knob, including the headworks and desilting basins at Imperial Dam and the Check and Wasteway at Pilot Knob, and for the first 49 miles of the Coachella Canal (Station 0 to Station 2604) were transferred to the District on May 1, 1952.

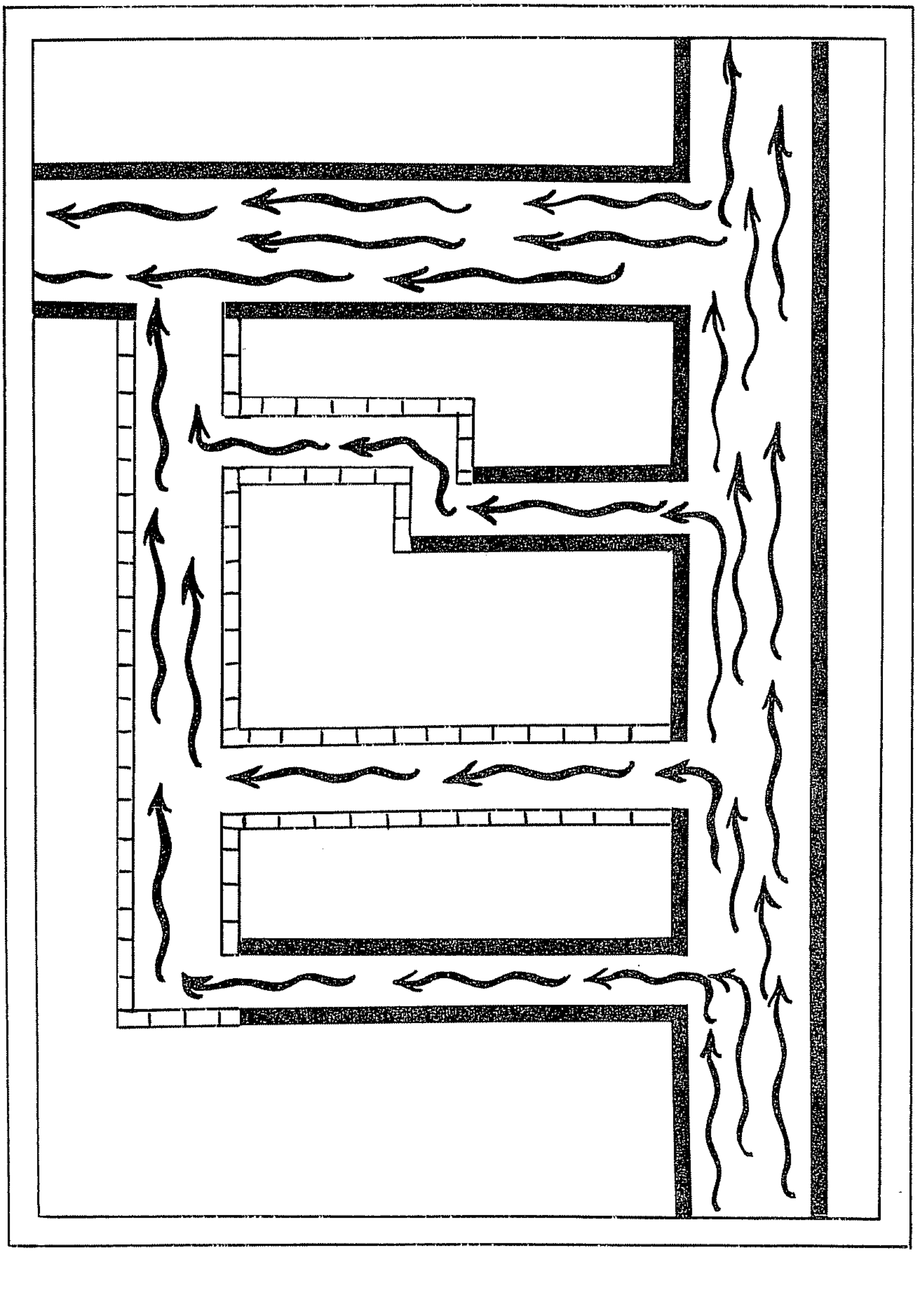
On November 18, 1980, water from the All-American Canal was diverted for the first time into the new initial 49-mile concrete-lined section of the Coachella Canal. This new section of canal replaced the adjacent original unlined section of canal. Operation and maintenance responsibilities were subsequently transferred to the Coachella Valley Water District. This new section of canal was constructed by Reclamation pursuant to Title I of the Colorado River Basin Salinity Control Act of June 24, 1974 (Public Law 93-320, 88 Stat. 266).

On December 7, 1982, Reclamation and the District entered into a contract whereby operation and maintenance responsibilities for the California Sluiceway at Imperial Dam, Senator Wash Dam and Reservoir, and Laguna Dam, which is located downstream from Imperial Dam, would be transferred to the District. The transfer became effective on January 1, 1983. The operating agreement became effective on March 21, 1983. Senator Wash Dam and Reservoir is an offstream pumping-generating facility located about 2 miles upstream from Imperial Dam on the California side of the Colorado River.

In the interest of operating efficiency, Reclamation policy is to transfer operation and maintenance responsibilities of completed facilities to water users. However, supervision of water scheduling and dispatching activities, regulation of flood inflows and releases and irrigation water not needed by water users, and coordination of river operations in conjunction with floodflows on the Gila River are retained by Reclamation. In addition, Reclamation retains title to all such facilities.

Legal authorities relevant to the Colorado River are appended. These authorities are sometimes referred to as the "Law of the River."

PROBLEMS AND OPPORTUNITIES



II. PROBLEMS AND OPPORTUNITIES

A. Problems

While California agencies have contracts with the Department of the Interior totaling 5.36 million acre-feet per year for Colorado River water, the U.S. Supreme Court decree in Arizona v. California, 376 U.S. 340 (1964), apportioned 2.8 million acre-feet per year to Arizona, 4.4 million acre-feet per year to California, and .3 million acre-feet per year to Nevada when there are 7.5 million acre-feet per year available for beneficial consumptive use in the three states. The decree also apportioned any water in excess of 7.5 million acre-feet per year with 46 percent to Arizona, 50 percent to California, and 4 percent to Nevada. After the Central Arizona Project (CAP) commences deliveries, now scheduled for late 1985, California will be limited to 4.4 million acre-feet of the waters apportioned to the Lower Basin States except in years when the Secretary of the Interior determines that a surplus condition exists or permits California to use a portion of Arizona's or Nevada's unused apportionments. The Colorado River Basin Project Act of 1968 provided for California's annual apportionment of 4.4 million acre-feet per year by limiting diversions for the CAP in years when there is insufficient water available to satisfy 7.5 million acre-feet of consumptive use in the Lower Basin States.

The California Seven-Party Priority Agreement, which sets forth the priorities to Colorado River water for each California agency, apportions the first three priorities, totalling 3.85 million acre-feet per year, to California's agricultural users - the Palo Verde Irrigation District, the California portion of the Yuma Project, the Imperial Irrigation District, and the Coachella Valley Water District. The Metropolitan Water District of Southern California (MWD), which has been able to divert up to about 1.2 million acre-feet per year under the fourth and fifth priorities of the Seven-Party Priority Agreement, therefore, will be limited to that diversion limiting consumptive use to .55 million acre-feet per year when California's consumptive use is limited to 4.4 million acre-feet per year. Small miscellaneous rights and existing lower Colorado River Indian Tribes' rights not included in the Seven-Party Priority Agreement, but having a higher priority than MWD, could reduce MWD's entitlement to slightly less than .5 million acre-feet per year. A lawsuit, now pending in Federal district court regarding disputed Indian Reservation boundary lines, could further reduce MWD's priority rights.

The California State Water Project (SWP), begun in the early 1960's as a means to more evenly distribute the state's water supplies from north to south, has been planned as the replacement source for the reduced water supply to MWD from the Colorado River, and to meet MWD's future increased water demands. The SWP was originally expected to produce an ultimate annual yield of 4.23 million acre-feet per year. The dependable yield for 1980, however, was 2.3 million acre-feet, or about one-half the water supply the SWP was intended to provide. Dependable yield will be reduced to the 1.6 to 1.8 million acre-foot range due to increased use in the areas of origin, maturity of contracted obligation of the Federal Central Valley Project, and other prior rights.

The SWP is still incomplete. The range of water supply alternatives which has been, or remains under consideration by the State of California to increase SWP yield, is shown in Table 3. All surface-water alternatives shown assume the construction of a cross-Delta facility. Many of the alternatives are variations of one or another. Therefore, the development of some would preclude the development of others. Some alternatives have been deferred because of social, legal, or political restraints. Other alternatives have been deferred due to prohibitive costs. When the necessary additional features will be available to increase SWP's dependable supply is uncertain. Construction of planned facilities will be costly, time consuming, and in many instances, politically sensitive.

The subject of water supplies available to MWD under various demand scenarios is well documented in MWD's Report No. 948, dated August 1983. From that report, Table 4 was prepared showing that with existing facilities, shortages in dependable supply can be expected by 1990 or before under both normal and above-normal (periods of high temperatures and low precipitation) demand conditions. By the year 2000, the shortages could be as high as 630,000 acre-feet per year and 910,000 acre-feet per year, respectively.

The age, design, and extensive nature of the District's 1,600-mile distribution system hamper the most efficient operation, resulting in undesirable operational waste, excessive canal seepage, and fluctuating deliveries to District farmers. Old, mostly manually-operated gates and controls; leaky, unlined canals; and limited regulatory storage in the system contribute to water control problems. As a result, about 912,000 acre-feet per year of surface and subsurface return flows leave the District and enter the Salton Sea (Sea).

District orders for water from the Colorado River are not sufficiently precise to meet all water needs in a timely manner. Several factors affect the District's ability to order and receive precise amounts of water. First, the District is located far enough away from the source of its water supply that water travel times require placing orders three days in advance of need. Second, due to changing weather conditions, more or less water may arrive at Imperial Dam than is needed. For example, sudden hot, dry, windy conditions can increase crop water needs beyond what is available in the distribution system. Sudden localized rainstorms can reduce irrigation needs to the point that flows greater than needed to satisfy Mexican water needs are passed downstream to the Gulf of California

Table 3
STATE WATER PROJECT
WATER SUPPLY ALTERNATIVES 1/
Water Conservation Opportunities
Imperial Irrigation District, California

Water Supply Alternatives	Yield (1,000 ac-ft/yr)	1981 Unit Cost ($/ac-ft)
WASTE WATER RECLAMATION		
Las Virgines	5.0 to 6.0	275 to 300
Goleta	1.0 to 8.6	700
Simi Valley	2.5	---
Lower Chino	17	---
San Juan Basin	3.9	---
San Joaquin	25	300
GROUND WATER		
Chino Basin	137	210
Orange County	17	185
Raymond Basin	6	190
San Fernando Valley Basin	21	155
Kern River Fan Area Basin	207	69
Livermore	6	58
SURFACE WATER		
Peripheral Canal	700	100
Cottonwood Creek	200	200
Thomes-Newville	220	245
Glenn Reservoir-River Diversion Plan	1,210	230
Los Vaqueros	265	325
Shasta Lake Enlargement	1,400	175
Colusa	190	285
Lake Berryessa Enlargement	1,650	125
Corral Hollow	160	600
Los Banos Grandes	250	330
Colorado River Banking Plan	800 to 370	---
Agricultural Water Purchase Plan	100	---

1/ State of California, The Resources Agency, Department of Water Resources. State Water Project - Status of Water Conservation and Water Supply Augmentation Plans. Bulletin No. 76-81. November 1981.

Table 4
TYPES AND AMOUNTS OF SERVICE AREA DEMANDS AND SOURCES AND AMOUNTS OF SUPPLY PROJECTED FOR THE YEARS 1985, 1990, AND 2000 1/

Service Area Demands and Sources of Supply	1985	1990	2000
	(million acre-feet/year)		
Demands			
Normal 2/	3.19	3.35	3.61
Above Normal 3/	(3.50)	(3.67)	(3.96)
Sources of Supply 4/			
Local			
Normal Demand	1.11	1.11	1.12
Above Normal Demand 5/	(1.18)	(1.18)	(1.19)
Los Angeles Aqueduct	0.47	0.47	0.47
Colorado River	0.46	0.45	0.40
State Water Project	1.13	1.08	0.99
Total			
Normal Demand	3.17	3.11	2.98
Above Normal Demand	(3.24)	(3.18)	(3.05)
Shortages			
Normal Demand	0.02	0.24	0.63
Above Normal Demand	(0.26)	(0.49)	(0.91)

1/ The Metropolitan Water District of Southern California. Water Supply Available to Metropolitan Water District Prior to Year 2000. Report No. 948, August 1983.

2/ Normal demand assumes a "normal" rate of population growth.

3/ Above normal demand represents the demand that would occur during years of low rainfall and high temperatures in southern California.

4/ Sources of supply are based on existing facilities.

5/ Assumes additional ground-water pumping by local agencies.

or allowed to flow through the distribution system and then discharged into the Sea. Insufficient regulatory storage is available to relieve the problem.

Operational and water requirement changes fluctuate flows within the District's distribution system even though the system is operated to maintain near constant flows. During a typical day, flows may fluctuate several times. Figure 1 shows how the flow to a lateral can be constant on some days and fluctuate on other days. These fluctuating flows can cause inaccurate deliveries to farmers and excessive operational spills.

Although the irrigation water use efficiency of the District is the highest for any irrigation district in the Lower Colorado Region, considerable improvement can be made before reaching reasonably attainable levels of efficiency. Distribution system delivery problems, outmoded irrigation application methods and techniques, and imprecise irrigation timing limit onfarm irrigation efficiencies. Little economic incentive for greater water conservation on the part of most farmers exists because water costs represent only a small portion of the farm production budget.

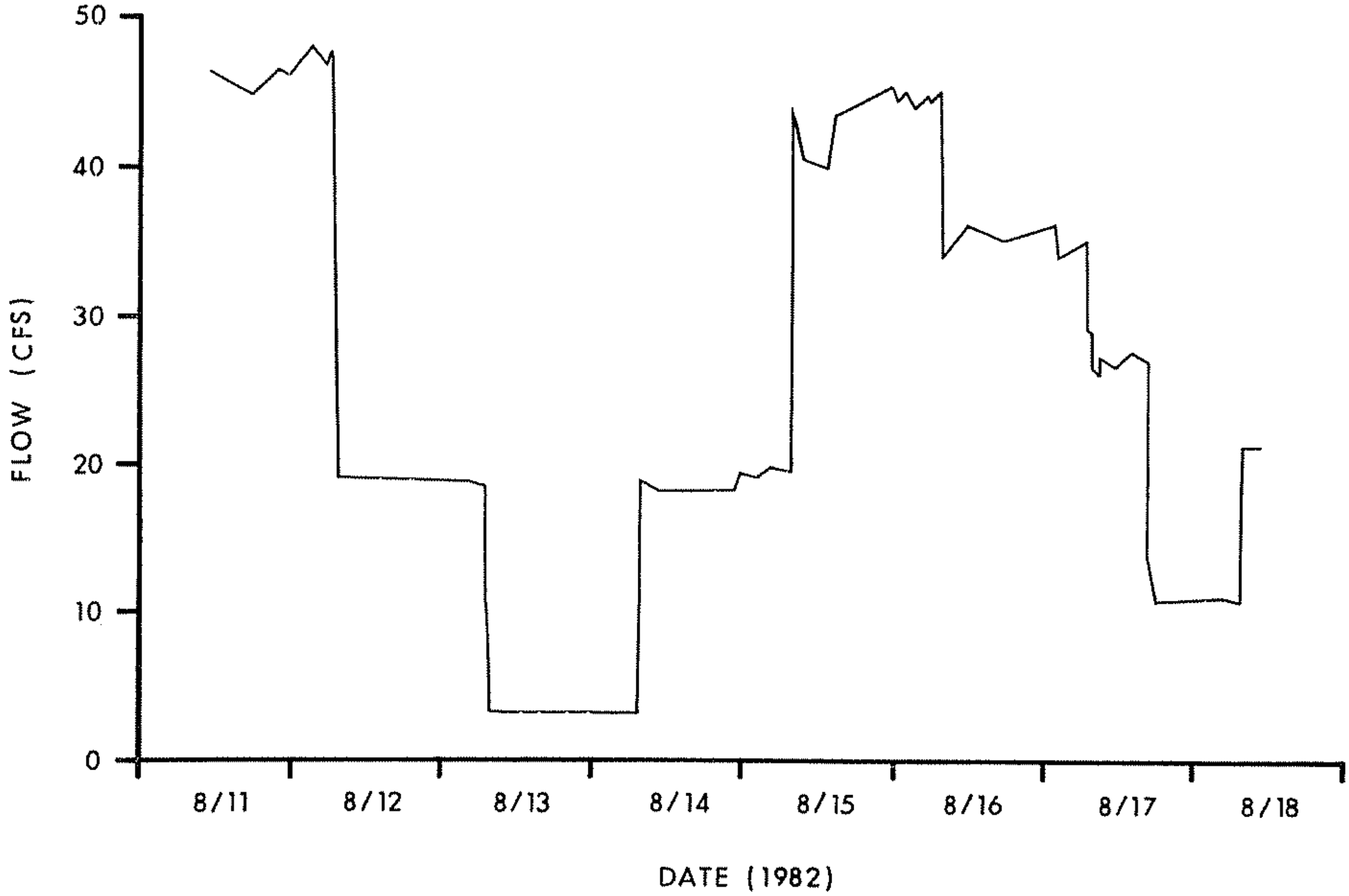
Fluctuating farm water delivery is a major problem in achieving maximum irrigation efficiency. Figure 2 shows how a farm delivery can fluctuate several times during the course of an irrigation. These fluctuations have been measured on 80 fields and have been found to vary as much as 20 percent of the ordered flow. Because of these variations, growers tend to order more water than what is actually needed in order to insure a sufficient supply. Excessive deep percolation and tailwater flows often result.

Due to irrigation return flows and inflows resulting from heavy storm runoff during the past 6 or 7 years from throughout the Salton Sea Basin, the elevation of the Sea has been rising. As a result of rising water levels, adjacent fields, irrigation works, marinas, homes, and wildlife refuges have been inundated. In response to flood losses, several lawsuits have been filed against the District. A number of these lawsuits charge the District with wasteful and unreasonable policies and practices.

In addition to the problem of rising Sea elevations, evaporation, the only source of outflow from the Sea, is concentrating the salts in the Sea. The salinity concentration in the Sea has increased to the point where the survival of the Sea's fishery resource is in doubt.

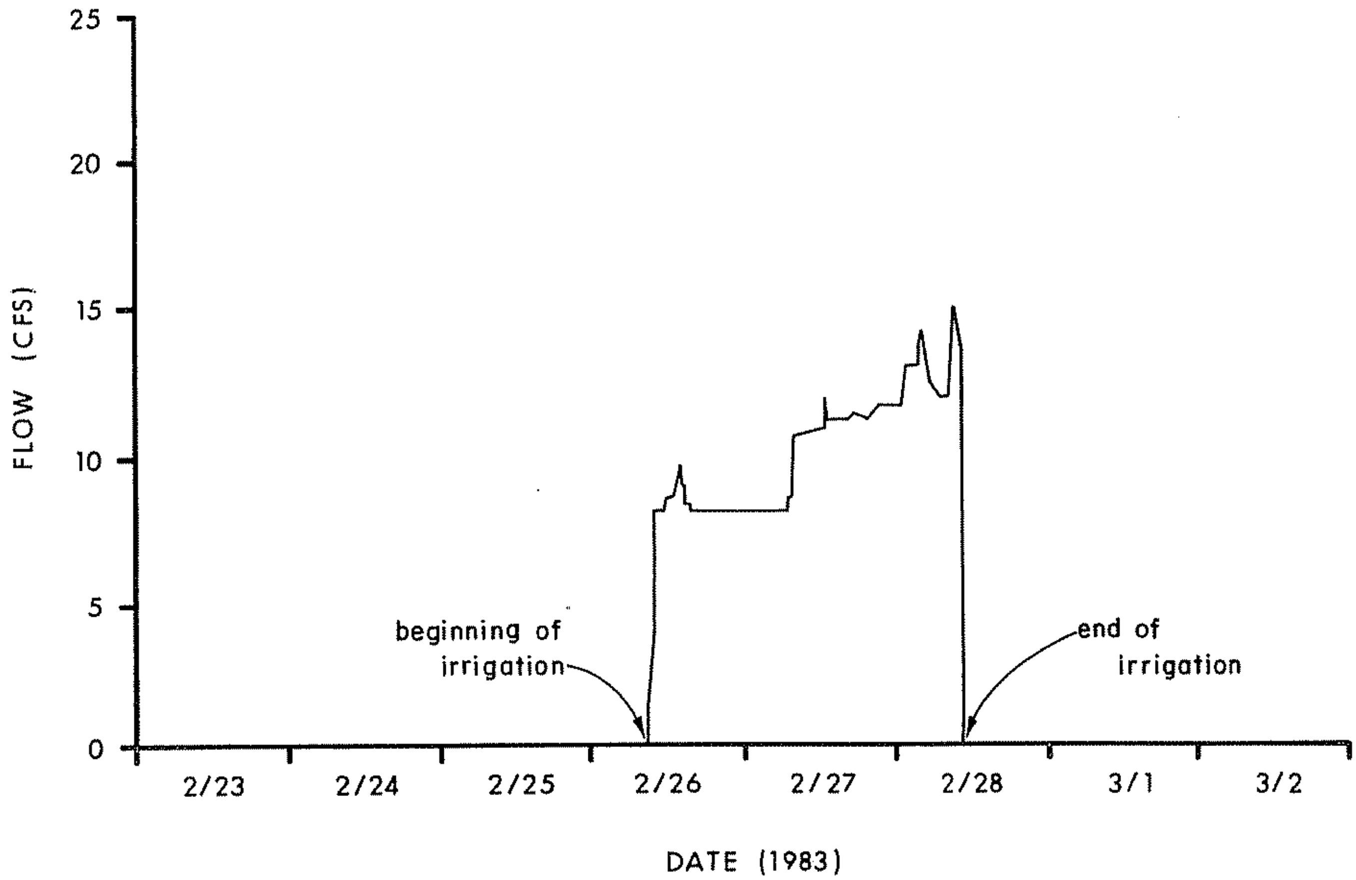
B. Opportunities

Studies indicate several Reclamation water conservation projects could provide new sources of water to meet some of the projected needs for southern California. Table 5 displays several ongoing Reclamation investigations and projected estimated annual yields and unit costs of water conserved by these proposed projects.



MAPLE LATERAL INFLOW

FIGURE 1



FARM DELIVERY – TURNOUT ORANGE 27

FIGURE 2

Table 5
ONGOING RECLAMATION INVESTIGATIONS AND PROJECTED
ESTIMATED ANNUAL YIELDS AND UNIT COSTS OF CONSERVED WATER
Water Conservation Opportunities
Imperial Irrigation District, California

Ongoing Reclamation Investigations	Estimated Annual Yield (ac-ft/yr)	Estimated Unit Cost ($/ac-ft)
All-American Canal Relocation	70,000 1/	180 2/
Lower Colorado Water Supply	10,000 3/	4/
Coachella Valley Water District, Water Conservation Opportunities	50,000 est.	4/
Water Conservation Opportunities, Imperial Irrigation District	354,000 est.	45 2/
Total	484,000	

1/ About 40,000 acre-feet have been identified for possible Federal use as Yuma Desalting Plant reject stream replacement.

2/ Preliminary estimate.

3/ This water is for use outside of MWD's service area.

4/ Not available.

Even if MWD were to obtain the entire 484,000 acre-feet of potential conserved water listed in Table 5, the yield would not be adequate to offset the normal demand shortage projected by MWD by the year 2000. Feasible water supply alternatives are offered, in some cases, at apparent less cost than alternatives that could be developed via the SWP. Even though a project in the Colorado River basin appears less costly from an economical standpoint, this may not be true from a financial standpoint as costs of SWP projects can be financed at a melded interest rate of 4.7 percent.

In most irrigation districts, some of the water diverted for use eventually reenters the supplying water source as return flow. Such water is then made available for use downstream. Since the District is located in a unique geological area, return flows cannot reenter the Colorado River, but drain, instead, into the Sea. These return flows, once they enter the Sea, cannot be made available for further agricultural or M&I use in the Imperial Valley or downstream on the Colorado River. Conservation projects within the District, therefore, provide the only opportunities to minimize return flow.

Wilson

United States Department of the Interior

BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL OFFICE
P.O. BOX 427
BOULDER CITY, NEVADA 89005

IN REPLY REFER TO: LC-737
453.

JUL 30 1985

To: All Recipients, Water Conservation Opportunities, Imperial Irrigation District, California Special Report, July 1984

ERRATA

Questions have been raised concerning the content or intent of the material presented in the special report relative to existing water laws. As noted in the preface to the special report, nothing in the study is intended to interpret the provisions of Federal laws, treaties, or court decrees. Nor is anything in the study intended to interpret the provisions of the water contracts between the California water users and the United States. Further, the special report is not intended to interpret the relationship of State and Federal law governing the use of Colorado River water by California water users nor to define limits or expand on the Imperial Irrigation District's right to use Colorado River water. Therefore, page 20 of the special report should be replaced with the enclosed page 20(Rev.) which has been revised to provide clarification.

The intent of the material in the special report is limited solely to assuring Federal administrators and planners that additional plan formulation studies are justified.

Sincerely yours,

Robert A. McCullough

Roy D. Gear
Acting Regional Director

Enclosure

The contribution water conservation measures can make toward alleviating a projected water supply shortage depends upon the time frame required for implementation. While water conserved by constructing various structural facilities can be specifically identified upon completion of construction, water conserved through changes in agricultural practices may take a generation or longer to realize, depending upon the perceptions of the individual farmers. Therefore, identification of practical measures with a high degree of confidence of yielding a predictable and measurable annual increment of new water is essential.

Reclamation's water conservation studies complement MWD's stated policy of actively investigating all means of increasing future water supplies. MWD recommends support of Colorado River augmentation and reduction of agricultural water losses and has expressed an interest in working closely with the District and the Coachella Valley Water District in their respective water conservation programs. MWD has also indicated support of other Reclamation water conservation programs. Future public involvement will include discussions on MWD participation and cost-sharing in both planning and construction activities.

If the conserved water was to be used by the MWD, the priorities of Coachella Valley Water District, the Palo Verde Irrigation District, and the Yuma Project in California would have to be considered. The District obtains its supply from water stored behind Hoover Dam under a Federal contract. The signing of a contract was required by the Boulder Canyon Project Act (Section 5). The District's contract as well as the contracts with the Coachella Valley Water District, the Palo Verde Irrigation District, and the Metropolitan Water District contain the provisions of the California Seven-Party Agreement, fixing priorities to use of Colorado River water among California users.

Under provisions of the Federal contracts, the District shares the third and sixth priorities with the Coachella Valley Water District and Palo Verde Irrigation District. MWD holds the fourth and fifth priorities. Therefore, any water made available by District water conservation and not used within the District would be available to Coachella Valley Water District, Palo Verde Irrigation District, and MWD in accordance with the Federal contracts.

The District holds present perfected rights under the U.S. Supreme Court Decree, Arizona v. California. If there is insufficient water to meet California's 4.4 million acre-foot apportionment, the Secretary of the Interior is obligated to meet first the present perfected rights in order of priority date from water stored behind Hoover Dam. Present perfected rights are the result of the actual diversion of water and application to a defined area of land as of 1929 and are more specifically identified in a supplemental Decree of the United States Supreme Court on January 9, 1979 (439 U.S. 419).

The contribution water conservation measures can make toward alleviating a projected water supply shortage depends upon the time frame required for implementation. While water conserved by constructing various structural facilities can be specifically identified upon completion of construction, water conserved through changes in agricultural practices may take a generation or longer to realize, depending upon the perceptions of the individual farmers. Therefore, identification of practical measures with a high degree of confidence of yielding a predictable and measurable annual increment of new water is essential.

Reclamation's water conservation studies complement MWD's stated policy of actively investigating all means of increasing future water supplies. MWD recommends support of Colorado River augmentation and reduction of agricultural water losses and has expressed an interest in working closely with the District and the Coachella Valley Water District in their respective water conservation programs. MWD has also indicated support of other Reclamation water conservation programs. Future public involvement will include discussions on MWD participation and cost-sharing in both planning and construction activities.

No significant legal constraints have been discovered to prevent conserved agricultural water from being used for municipal and industrial (M&I) purposes. The use of the District's water for M&I purposes is legally possible, may be accomplished without congressional approval, and would be consistent with existing Federal and state law.

Federal law does not preclude the exchange of water for services between the District and MWD. The District's water rights were held before the Imperial Dam and the All-American Canal were authorized by the Boulder Canyon Project Act of 1928. These "present perfected rights" are a limitation upon the Secretary's authority to allocate Colorado River water and to impose the restrictions of reclamation law on water users, Arizona v. California, 376 U.S. 340 (1964). The Supreme Court held in 1980 that the Secretary, in satisfaction of "present perfected rights," must take account of state law which governs the extent of those rights, Bryant v. Yellen, 447 U.S. 352 (1980). Therefore, the rights which the District possesses in its water supply are determined under California law.

California law allows for sale of surplus water by irrigation districts as long as the water right itself is not transferred. In fact, the California Water Code, in Section 109, encourages voluntary water transfers ". . . where consistent with the public welfare of the place of export and the place of import."

The California Seven-Party Priority Agreement fixes priorities in Colorado River water among California users. The District presently shares the third and sixth priorities with the Coachella Valley Water District. MWD holds the fourth priority and, therefore, would be in line to take the surplus created by District water conservation. However, the priorities of the Coachella Valley Water District will have to be taken into consideration in any negotiations.

MWD already has capacity in the Colorado River Aqueduct to convey any conserved Colorado River water to southern California. New construction would not be required to put any conserved water to use. However, such uses by MWD may have some impact on downstream water supplies. Likewise, conserved water diverted by MWD would no longer be available for power generation between Lake Havasu and the Imperial Valley. Reduced flows below Parker Dam could also have an impact on salinity concentrations at Imperial Dam.

In addition to potential M&I use of conserved water, additional agricultural water could be used in the Imperial Valley. Only about one-half of the District's potential agricultural land has been developed due to the lack of adequate water supplies. The Coachella Valley Water District also has lands that are undeveloped due to the lack of adequate water supplies. However, an existing agreement between the District and the Coachella Valley Water District would probably prevent the development of significant quantities of new land.

In order to maximize water use efficiency and to conserve water, the distribution system must deliver water to the grower at the time and in the amount needed to satisfy crop water needs. At the same time, operational and other system losses must be minimized. Features such as canal lining, regulating reservoirs, and system automation could help provide more precise water control and help maximize system operating efficiency. The use of computerized system scheduling to improve methods of determining where and when water is needed throughout the 1,600-mile distribution system could also enhance control precision and minimize the release of unneeded water from Parker Dam. These features provide an opportunity of conserving up to 215,000 acre-feet of water per year to help relieve projected water shortages.

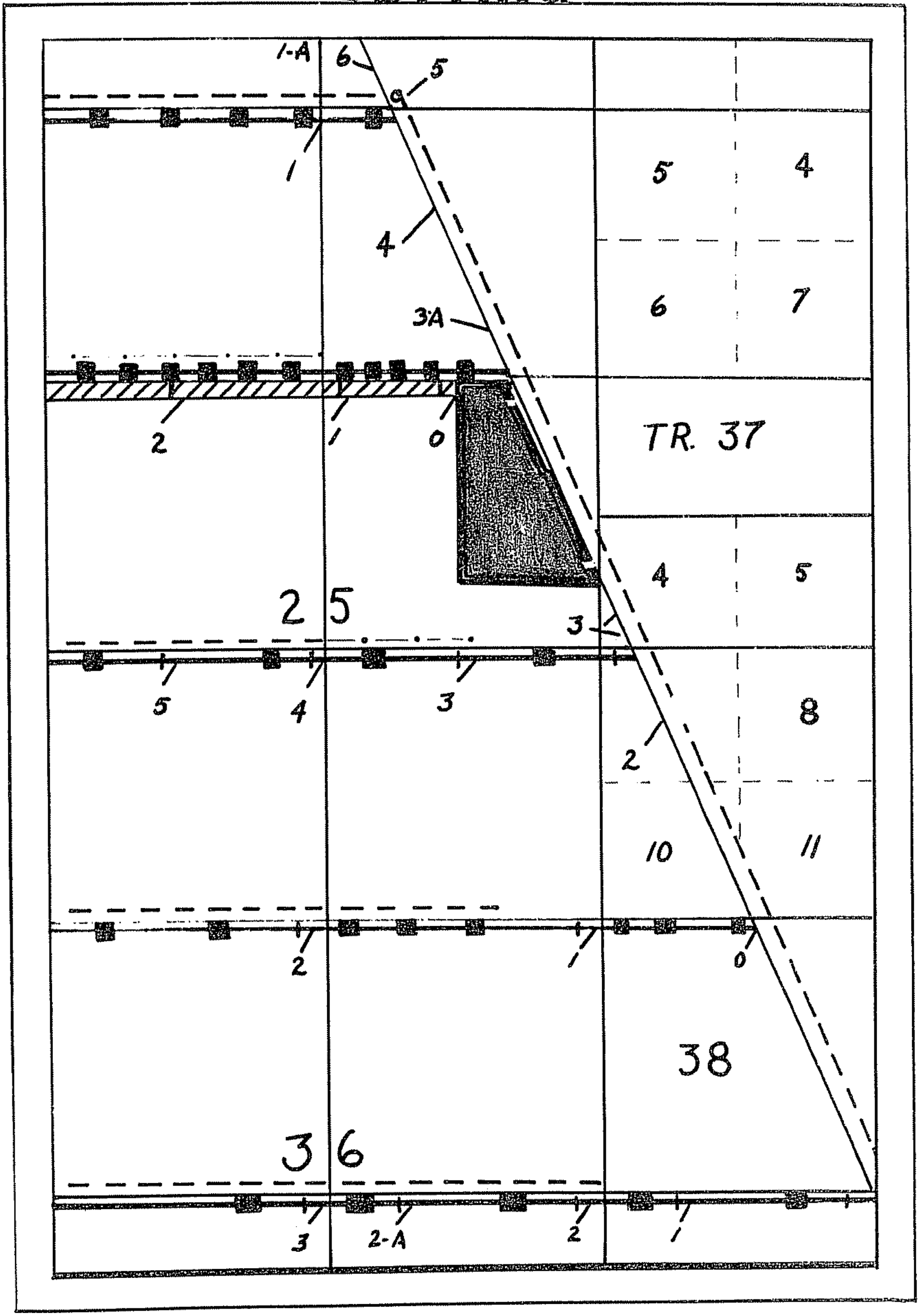
Improved onfarm efficiency resulting from eliminating unneeded irrigations, from reducing excessive tailwater, and from eliminating deep percolation in excess of leaching requirements requires changes in present irrigation and water delivery practices. Precise determination of both crop water needs and water delivery rates are essential for good onfarm water management. The use of the latest technology involving the neutron moisture gage and infrared thermometer would permit precise determination of proper irrigation timing and required amounts to be applied. Installation of accurate measuring devices at farm turnouts would permit more precise application of irrigation water. Improving water use efficiency on the farms could ultimately conserve an additional 135,000 acre-feet of water per year.

Nonstructural methods of conserving water using new technologies require changes in operating practices and procedures by the District and growers alike. Substantial and effective demonstration programs provide an opportunity to show the effectiveness of system scheduling, field irrigation scheduling, and other conservation measures while providing a means for gradual implementation of these conservation measures. System operators and growers must be assured that these measures are effective and that an adequate water supply for the crops can be maintained while accomplishing water conservation.

Some stabilization of Sea water levels can be achieved through a District water conservation program by reducing irrigation return flows. Reduced inflow could help lower water levels several feet below the current elevation and thereby relieve present flooding problems. However, reduced inflows will lessen the dilution of salts in the Sea and accelerate salt concentration caused by evaporation. The accelerated salt concentration would adversely impact the recreation and fishery resources of the Sea.

Some impacts on wetlands, open drains, the Alamo River, and the New River are anticipated as conservation features reduce seepage and flows into the drainage system. Some special status species may be impacted.

SETTING



III. SETTING

A. Location

The District is located in Imperial County, California as shown on the Frontispiece Map. The District itself is bounded on the east by the Cargo Muchacho Mountains and the Chocolate Mountains; on the northeast and north by the Chocolate Mountains and the Chocolate Mountains Aerial Gunnery Range; on the northwest by the Salton Sea; on the west by the Superstition, Fish Creek, Vallecito, Coyote, and Jacumba Mountains; and on the south by the International Boundary with Mexico.

El Centro, the largest city in the county and the county seat, is located in the southwestern portion of the District about 60 miles west of Yuma, Arizona, and about 120 miles east of San Diego, California. Brawley, the second largest city in the county, is located in the north central portion of the District about 14 miles north of El Centro.

B. Natural Environment

1. Geology. The Imperial Valley, Salton Sea, Coachella Valley, and Mexicali Valley occupy most of the northern portion of the unique geologic structure known as the Salton Trough (Trough). The southern portion of the Trough is occupied by the Gulf of California. The Trough is part of the extensive rift zone running through northwestern Mexico and southern and central California.

Most of this northern portion of the Trough is located below sea level. The lowest part is occupied by the Salton Sink (Sink). At 278 feet below sea level, the Sink is the focal point of the Salton Sea Basin (Basin). The Basin is bounded on all sides by mountains and hills. Since water cannot flow out of the Basin, a closed drainage pattern has been established. The Sink has been covered by the waters of the Sea since the flood of 1905-1907 when the Colorado River left its normal channel and flowed into the Sink.

Geologic analyses of the area indicate that continuous sediment deposition by the Colorado River eventually created a delta which separated the Basin from the remainder of the Trough. In addition, these analyses indicate the Basin is filled primarily with fresh-water deposits. Occasional marine deposits have also been identified. The fresh-water deposits apparently resulted from periodic inflows of Colorado River water. Marine deposits apparently resulted from infrequent inundation by the Gulf of California. The periodic inflows of Colorado River water created and recreated ancient Lake Cahuilla. Evidence of old lake shorelines can still be seen on the hillsides and mountainsides which border the Imperial and Coachella Valleys.

2. Seismicity. The Imperial Valley is located in one of the most seismically active areas in the United States. The Trough is bounded and cross cut by a number of seismically active fault systems. The San Andreas Fault Zone (Zone) forms the northeastern border of the Trough. Further northwest, in the Coachella Valley, the zone's principal branches are the Banning and Mission Creek faults. These faults merge into a single major fault in the southwestern portion of the Indio Hills. Seismic activity along these fault systems has apparently been producing earthquakes in the Trough area for thousands of years.

Numerous earthquakes have been recorded during historic times. Since 1900, about 45 events of Richter Scale magnitude 5.0 to 5.9 and 15 events of magnitude 6.0 or greater have occurred in the Trough area. The event of May 18, 1940 produced a magnitude of 7.1. Horizontal displacement of 15 feet occurred in the vicinity of the epicenter southeast of El Centro near the International Boundary. Vertical displacements up to 4 feet were also observed. Structural damage was severe in many areas of the Imperial Valley. The damage sustained by the Imperial Canal, through which the Imperial Valley was still receiving its water supply, was severe enough to interrupt water service. Other parts of the irrigation system also sustained heavy structural damage, but by putting the still uncompleted All-American Canal into temporary emergency service, water delivery was reestablished and disaster was averted.

On October 15, 1979, an earthquake of magnitude 6.5 struck the Imperial Valley. In the vicinity of the epicenter, about 10 miles east of Calexico, a 10-mile section of the All-American Canal sustained severe structural damage. Material from collapsed earthen levees sloughed into the canal interrupting water service. Around-the-clock repair efforts succeeded in reestablishing water deliveries by October 19, 1979.

3. Physiography. The Basin is bounded on the east by the Cargo Muchacho, Chocolate, Chuckwalla, and Orocopia Mountains; on the northeast and north by the Little San Bernardino Mountains; on the northwest by the San Bernardino Mountains; on the west by the San Jacinto, Santa Ysabel, Laguna, and Jacumba Mountains; and on the south by low hills and rises in Baja California, Mexico.

The Basin encompasses a drainage area of about 8,360 square miles. Elevations within the drainage area range from over 11,500 feet above sea level at Mt. San Gorgonio in the San Bernardino Mountains to 278 feet below sea level at the bottom of the Sink. The Sea occupies the Sink.

The Sea is maintained by acting as the final repository for surface and subsurface irrigation return flows and for runoff from precipitation. The only outflow from the Sea is through evaporation. The Sea's surface elevation was 227.4 feet below sea level as of December 31, 1981. With a surface area of 360 square miles, the Sea is the largest inland body of water in the state.

Most of Imperial County, portions of Riverside, San Diego, and San Bernardino Counties, and a small part of Baja California, Mexico, are located within the drainage area.

The Imperial Valley is separated from the Coachella Valley by the Sea and from the Mexicali Valley by a remnant of an ancient Colorado River delta about 30 feet in elevation above sea level.

The District is located entirely within Imperial County. The District measures about 50 miles south to north and about 50 miles east to west. The District's irrigation service area encompasses a total gross area of 1,062,290 acres and is divided into the East Mesa, Imperial, Pilot Knob, and West Mesa Units. Elevations within the East Mesa Unit range from about 200 feet above sea level near the Sand Hills to about sea level near the East Highline Canal. Elevations within the Imperial Unit range from about 35 feet above sea level near the East Highline Canal Turnout on the All-American Canal to about 227.4 feet below sea level along the shoreline of the Sea. Virtually the entire unit is located below sea level. Elevations within the Pilot Knob Unit generally range between 225 and 375 feet above sea level. Elevations within the West Mesa Unit range from over 200 feet above sea level near the foothills of the Fish Creek and Coyote Mountains to about 100 feet below sea level near the New River. The East Mesa Unit and the Pilot Knob Unit are separated by the Sand Hills. Most of the West Mesa Unit is separated from the Imperial Unit by the Superstition Mountains.

4. Climate. The Imperial Valley is located in one of the warmest and driest areas in the United States. The area's desert climate is characterized by long, hot, dry summers and by relatively short, mild winters. The Imperial Valley receives more sunshine during the year than almost any other place in the United States. Crops are grown 12 months out of the year.

The climatological characteristics of the Imperial Valley are reflected primarily by the data recorded at the District's weather station at Imperial. The data base covers the years 1914 to 1982, inclusive.

The average annual temperature is 72.4°F. Typical summer daytime temperatures range between 100 and 110°F. Temperatures as high as 119°F have been recorded. Daytime temperatures exceeding 100°F have been recorded as early as March and as late as October. Nighttime temperatures range between 75 and 85°F. Typical winter daytime temperatures range between 65 and 75°F. Temperatures as high as 90°F have been recorded in December and January. Nighttime temperatures range between 30 and 40°F. Temperatures as low as 16°F have been recorded. Nighttime temperatures occasionally fall to 32°F or below from November to February.

The average annual precipitation is 2.87 inches. Annual precipitation has ranged from 0.16 of an inch to 8.52 inches. Most of this precipitation falls as gentle widespread rains during the November to March period. These winter rains sometimes last for several days causing most of the moisture to percolate into the ground. Localized thunderstorms during the August to early October period can produce high intensity rainfall of short duration. Flash flooding can result in severe surface erosion.

The only snowfall of record to cover the entire Imperial Valley occurred in December 1932. Maximum accumulated snow depth measured 4 inches in the southeast portion. The annual relative humidity averages about 30 percent.

Winds are often light or variable throughout the year. The prevailing wind is from the southwest. Strong southwesterly to northwesterly winds can occur during the spring and fall in association with the passage of major frontal systems. Strong winds can also occur during severe localized thunderstorms.

5. Hydrology. Estimates for a water budget for the District indicated by analyses of existing data for the 1977 to 1980 study period are displayed in Table 6.

Table 6
ESTIMATES FOR A WATER BUDGET FOR THE DISTRICT
INDICATED BY ANALYSES OF EXISTING DATA FOR THE
1977 TO 1980 STUDY PERIOD
Water Conservation Opportunities
Imperial Irrigation District, California

Inflow	(1,000 ac-ft/yr)	Outflow	(1,000 ac-ft/yr)
Drop No. 1	2,734	Crop Consumptive Use	1,800
Precipitation on Canals	3		
Surface Flows from Mexico	128	Phreatophytes	96
Coachella Canal Seepage	100	Surface Flows to Sea (measured)	1,157
Precipitation	150	Underflow to Sea	50
Underflow from Mexico	13	Evaporation (canals)	25
Total	3,128	Total	3,128

The figures for Drop No. 1, surface flows from Mexico, Coachella Canal seepage, and surface flows to Sea (measured) were based on flow measurements and should be reasonably accurate. Coachella Canal seepage is based on the seepage measured during the study period before the original initial 49-mile unlined section of canal was replaced by an adjacent new 49-mile concrete-lined section of canal. Canal seepage is assumed to be inflow to, and to comingle with, the ground water underlying the District due to the relative differences in elevation between the canal and the Sea, the shape of the drainage basin, and ground-water contours indicating movement toward the Sea. Ground water underlying the District is either consumed by crops and phreatophytes or eventually flows into the Sea.

Precipitation was based on the 4-year average precipitation recorded at Imperial, California, of 4 inches over 450,000 acres. Underflow from Mexico was estimated to equal 10 percent of surface flows from Mexico. Crop consumptive use was the closure term in the budget. Phreatophytes were estimated to consume 6 acre-feet of water per acre over 16,000 acres in the Imperial Valley. Underflow to Sea was based on an estimate which appears in U.S. Geological Survey Professional Paper 486-C. Evaporation (canals) was based on the results of the canal lining study conducted as part of this water conservation opportunities study.

Table 7 itemizes components of an estimated water budget for the District based on the distribution of water delivered at Drop No. 1. The amount of water lost to canal and lateral seepage is highly dependent on two major assumptions: (1) that the amount of water delivered to customers is accurate; and (2) that the estimate of wasteway flows is accurate.

Estimates of farm deliveries are based on District billing records. There are occasions when water is ordered, but not taken, and this sometimes results in wasteway spills. For billing purposes in these instances, the records show the water order as a delivery. There are also occasions when, instead of wasting excess water, the excess water is offered to a customer at no charge. This situation is not reflected in the records of deliveries to customers.

The primary sources of wastewater in the District are: (1) canal and lateral seepage; (2) canal and lateral operational waste and spills; (3) deep percolation and leaching; and (4) tailwater spills.

The spills through main canal wasteways which are recorded amount to about 9,900 acre-feet per year. There are also about 193 canal and lateral wasteways identified for which spills are not recorded. The District recorded the spills on 41 of these wasteways for the year 1981. Data from these water level recorder readings indicate an average discharge of 376 acre-feet per year for each wasteway. Assuming this is true for all 193 wasteways, flows could be in excess of 72,600 acre-feet per year. Total spills for the measured and unmeasured wasteways could amount to about 82,500 acre-feet per year.

Table 7
ESTIMATED DISTRICT WATER BUDGET BASED ON THE DISTRIBUTION OF WATER DELIVERED AT DROP NO. 1
Water Conservation Opportunities
Imperial Irrigation District, California

Item	Annual Flow (1,000 acre-feet)	Percent of Diversion	Percent of Farm Delivery
Inflow at Drop No. 1 Plus Precipitation on Canals	2,737	100	
Canal and Lateral Seepage 1/	269	10	
Canal and Lateral Operational Waste and Spills	83	3	
Canal Evaporation	25	1	
Farm Delivery	2,360		100
Crop Consumptive Use 2/	1,800	66	76
Deep Percolation and Leaching 3/	236	8	10
Tailwater Spills 3/	324	12	14
Return Flow From Diversions 4/	912	33	
Surface- and Ground-Water Flows From Mexico	141		
Coachella Canal Seepage	100		
Precipitation	150		
Phreatophyte Consumptive Use	- 96		
Total Inflow To Salton Sea From Imperial Valley	1,207		

1/ Canal seepage is total computed canal seepage minus 36,000 acre-feet per year of recovered ground water.

2/ Consumptive use is the computed closure term from the District water budget.

3/ The break down between "deep percolation and leaching" and "tailwater spills" is estimated. The tailwater percentage is representative of data collected during the study.

4/ Return flow is canal and lateral seepage plus canal and lateral operational waste and spills plus deep percolation and leaching plus tailwater spills.

6. Ecology.

a. Aquatic Communities. The extensive irrigation and drainage systems in the District support various, and sometimes significant, aquatic habitats. Sizable gamefish populations do exist, but are generally underutilized. Canal seepage in non-farm areas and surface drains support marsh and riparian communities. A wide variety of flora and fauna can be found in these communities.

(1) Canals, Laterals, Regulating Reservoirs, Surface Drains, and Associated Wetlands.

(a) Water Quality. Irrigation water is by far the highest quality water found in the District. Salinity ranges from 800 to 900 milligrams per liter (mg/L). Nutrients are also low. Nitrate levels range from 0.89 to 1.37 mg/L and orthophosphate levels range from 0.01 to 0.78 mg/L (Engineering-Science 1980). The U.S. Geological Survey (Geological Survey) has conducted a 4-year water analysis program on the All-American Canal. The analysis program indicated that toxic materials such as pesticides, herbicides, and metal ions were rarely detected.

The quality of the water found in surface drains is substantially poorer than the quality of irrigation water due to the leaching of salts. Quality parameters vary considerably due to local agricultural and irrigation practices.

(b) Vegetation.

(1) Algae. Investigations on the Coachella Canal provide the only base-source information available. These investigations (Baker and Paulson 1981) have identified 18 phytoplankton genera. Diatoms dominate the phytoplankton communities with 12 genera.

Filamentous blue-green alga (*Lyngbya* and *Oscillatoria*) are also present where substrates and velocities permit. Blue-greens usually thrive under polluted conditions. However, the presence of blue-greens does not necessarily indicate pollution. The densities of blue-greens fluctuate directly with irrigation demands and changing canal velocities (Engineering-Science, 1980).

(2) Macrophytes. Emergent and submergent species are both represented. Emergents are predominantly cattails (*Typha*) and reeds (*Phragmites*). A District bank stabilization program included the planting of these species along canal shorelines to prevent bank erosion.

Submergents appear more often in smaller rather than in larger canals. Plant growth sometimes restricts water movement and becomes a problem. Pondweed (*Potamogeton* spp.) and watermilfoil (*Myriophyllum* spp.) are the dominant submergents.

The submergent _Hydrilla verticillata_ has been reported west of the New River since 1977. _Hydrilla_ is an extremely prolific aquatic which attains densities that restrict or prevent canal flow and hinder water deliveries. Intensive investigations regarding possible control measures are in progress. The California Department of Fish and Game (Fish and Game) has closed infested areas to fishing and other recreational activities in order to prevent further spread of the plant.

(c) _Invertebrates_. Zooplankton communities appear to be extremely limited due to sustained velocities and lack of habitat diversity. For example, protozoans (_Centropyxis aculeata_), rotifers (_Euchlanis_ spp.), and the developmental stages of cyclopoid and harpacticoid copepods are the only organisms reported in the Coachella Canal (Baker and Paulson 1981).

Benthic communities, especially in the Coachella Canal, have been studied to some degree. Marsh and Stinemetz (1980) identified 17 distinct taxa of macroinvertebrates in the Coachella Canal. Baker and Paulson (1981) reported similar findings. Filter feeders (_C. manilensis_ and _chironomids_) and sediment ingesters (_oligochaeta_) were the predominant species.

Areas that supported emergent and submergent vegetation also supported higher invertebrate numbers. _Periphyton_, however, was found to be very productive on concrete structures such as checks, drops, and siphons. All canals lack invertebrates in numbers as well as in diversity (Marsh and Stinemetz 1980).

(d) _Fish_. Seventeen species of fish have been identified in the All-American Canal and 18 species have been identified in the Coachella Canal. Various sampling efforts (Engineering-Science 1980; St. Amant, et al. 1974) have been conducted on the larger canals, but none as thoroughly as Minckley, Rinne, and Mueller (1983). Table 8 displays Coachella Canal fish species composition as modified from Minckley. Minckley sampled three canal sections with different structural features. The total fish biomass of each sample section was consistently high, but varied substantially. Estimates of the standing crop for these sample sections were: 910 lbs/acre, 437 lbs/acre, and 5,300 lbs/acre. Species composition was predominantly channel catfish followed by carp, threadfin shad, flathead catfish, and sunfish.

Information on the fish communities found in the seeps and marshes paralleling the irrigation system is unavailable. However, the drainage system was sampled by Herrgesell (1975) and found to contain carp, golden shiner, redshiner, black bullhead, yellow bullhead, and mosquito fish. Fish and Game biologists have also collected channel catfish, largemouth bass, desert pupfish, and _tilapia_ spp. in some irrigation drains.

Table 8
COACHELLA CANAL FISH SPECIES COMPOSITION
(MODIFIED FROM MINCKLEY, 1983) 1/
Water Conservation Opportunities
Imperial Irrigation District, California

Species 2/	Number Collected	Sample Percent
Threadfin shad	2,927	32.2
Carp	233	2.6
Goldfish	1	4/
Red Shiner	564	6.2
Channel catfish	4,674	51.3
Yellow bullhead	2	4/
Flathead catfish	94	1.0
Striped bass	1	4/
Bluegill	301	3.3
Redear sunfish	79	0.9
Warmouth	4	4/
Black crappie	3	4/
Largemouth bass	216	2.4
Zill's tilapia	6	.1
Mosquito fish	3/	.0
Sailfin molly	3/	.0
Total	9,105	100.0

1/ Minckley, W. L.; Rinne, W.; and Mueller, G. Fishery Inventory of the Coachella Canal, Southeastern California. Journal of the Arizona-Nevada Academy of Science 18 (1983):39-45.

2/ Additional species may include bigmouth and razorback sucker.

3/ Observed, not collected.

4/ Less than 0.05 percent.

(2) Alamo River and New River. Both rivers enter the United States from Mexico and empty into the Sea. These rivers have similar water qualities and aquatic habitats. Roughly 50 miles of riparian habitat are associated with each river in the United States.

(a) Water Quality. The water quality of both rivers is considered to be poor. The water quality of the Alamo River is slightly better than that of the New River. Coliform bacteria counts of 23,000 to 62,000 MPN/100 ml. (Most Probable Number per 100 milliliters) have been recorded in New River water. These extremely high counts are due to the sewage water contributed by the city of Mexicali. Salinity concentrations fluctuate between 2,000 and 6,000 mg/L depending on seasonal irrigation diversion rates in the Mexicali Valley.

Both rivers are extremely turbid. Nitrogen and phosphorus levels are also quite high compared to other bodies of water in Imperial County. Nitrate and orthophosphate levels for the Alamo River, January 1979, averaged 50 mg/L and 0.201 mg/L, respectively, compared to levels averaging 2.4 mg/L and 0.47 mg/L, respectively, for water samples taken from the Sea near Wister (Engineering-Science 1980).

Geological Survey water quality analyses of Alamo River water have frequently detected varieties of pesticides, herbicides, and other toxic substances. Concentrations of less than 0.2 micrograms per liter have usually been found, although some levels reaching several micrograms per liter which can cause invertebrate and fish mortality have also been found.

(b) Vegetation.

(1) Algae. The algae communities of both rivers are extremely limited due to high turbidity, sustained velocities, and possible periodic influxes of herbicides.

The green algae (Cladophora) can be found in limited quantities in both rivers along with blue-green algae and fresh water diatoms (Navicula, Nitzschis, Synedra) (Engineering-Science 1980).

(2) Macrophytes. Submergent vegetation has not been reported in either river system, although extremely small quantities may exist. If submergents do exist, various pondweed and Eurasian-milfoil spieces would probably be included. Emergent vegetation is usually restricted to the river banks and includes dense stands of tules (Scirpus sp.), cattails (Typha spp.), and Carrizo cane (Phragmites australis).

(c) Invertebrates. Invertebrate data are limited for both river systems. Available data indicate that rotifers and cladocera are found. Benthic invertebrate fauna is apparently restricted to emergent vegetation and to debris found along shorelines. Chironomid larvae, mayflies, dytiscid beetles, dragonfly nymphs, Asian clams, and crayfish are also present (Engineering-Science 1980).

(d) Fish. The high concentrations of nonnative fishes now found in the Alamo and New Rivers are indicative of a totally modified historical fishery. A fish sampling effort undertaken by Engineering-Science in 1980 using various netting procedures yielded five species of fish. These species included carp, goldfish, channel catfish, yellow bullhead, and Tilapia spp. Carp accounted for 93 percent of the total catch. Largemouth bass, various sunfish, and other canal species may also be present.

Fish migration in the Alamo River is restricted by a large scale network of erosion control structures. Fish communities are maintained by natural reproduction and by downstream movement. Upstream migration from the Sea undoubtedly occurs for short distances. Those river areas which have moderate salinity levels may provide important reproductive habitat for the Sea's fishery. These river areas may become more important as salinity concentrations in the Sea continue to increase.

(3) Salton Sea. As a recreational area for southern California, the Sea's popularity is ever increasing. The Sea is currently regarded as one of the highest quality, self-sustaining sport fisheries in the state. The recreational area also provides boating, swimming, camping, picnicking, hunting, and birdwatching opportunities.

(a) Water Quality. According to a 1970 Federal Water Quality Administration report, the Sea's water quality for recreational uses is generally good and is unlikely to present any significant health or safety problems for recreationists in the future. The only areas considered bacteriologically unsafe for water contact recreation are located where the Alamo and New Rivers enter the Sea.

The Alamo and New Rivers discharge both surface and subsurface return flows into the Sea. Natural runoff from throughout the Basin also flows into the Sea. The Sea occupies the lowest part of a closed drainage basin. Since the only outflow from the Sea is through evaporation, all of the dissolved minerals which enter the Sea remain there. Water quality, therefore, especially in terms of salinity concentrations, is a major element in the survival of the Sea's aquatic organisms. Average annual salt inflow amounts to about 5 million tons. Salinity concentrations currently measure about 39,000 mg/L, or about 20 percent greater than ocean water.

In a closed drainage basin, accumulations of pesticides and herbicides may occur. Toxicity levels in the Sea, however, are not significant. In 1972, the Geological Survey Laboratory analyzed water samples taken from the Sea. These analyses indicated that the levels of chlorinated hydrocarbons in the Sea were within the acceptable standards identified in the "Water Quality Control Plan for Ocean Water of California."

(b) Vegetation. Twenty-two species of planktonic algae have been identified in the Sea (USDI, TRAC 1974). Diatoms and dinoflagellates comprise the majority of abundant species.

Other species include green algae and euglenaid algae. The four major species, Nitzchia longissima, Cyclatella caspia, Glenodinium sp., and Exuviells compressa, make up the bulk of the aquatic vegetation produced in the Sea (Linsley and Carpelan 1961).

The high nutrient inflows from the Alamo and New Rivers contribute to an extensive phytoplankton community typical of eutrophic systems. Periodic algal blooms result in fish kills, odors, and other anoxic conditions. Blooms have occurred since 1954 and are not expected to worsen (USDI, TRAC 1974).

(c) Invertebrates. The invertebrate diversity of the Sea, along with other aquatic organisms, is extremely limited due to the lack of habitat variety and the chemical composition of the water. Extensive introductions of various marine invertebrate species were made between 1930 and 1957, but with very limited success.

Six phyla of invertebrates (Protozoa, Rotifera, Bryozoa, Nematoda, Annelida, and Arthropoda) are found in the Sea. Zooplankton species include several protozoan species, the rotifer, Brachionus plicatilis, and the copepod, Cyclops dimorphus. Benthic organisms include the barnacle, Balanus amphitrite, various ostracods, nematodes, bryozoans, and the annelid, Neanthes succinea (Linsley and Carpelan 1961). Copepods, rotifers, barnacles, and the annelid, or "pile worm," provide important forage for fish.

(d) Fish. The Sea's fish community has changed continuously since the Sea's creation in 1905-1907. The original population was typical of that found in the Colorado River. Those fish species unable to tolerate the increasing salinity levels in the Sea, however, gradually succumbed as time progressed. Today, the desert pupfish (Cyprinodon macularius) is the only native fish found in the Sea.

Fish and Game conducted extensive introductions of various marine species between 1929 and 1956. Today, the fish community is represented by more than 11 species, including the threadfin shad, desert pupfish, mosquito fish, sargo, gulf croaker, orangemouth corvina, long-jawed mudsucker, sailfin molly, and several species of tilapia.

Freshwater fish are occasionally reported near the southern end of the Sea. Carp, sunfish, and catfish can enter the Sea from canals and the Alamo and New Rivers for short periods of time. Unless the fish return upstream, however, salinity stress will ultimately lead to mortality.

Orangemouth corvina, gulf croaker, tilapia, and sargo form the base of an extremely important and valuable fishery (Black 1974). Fishing estimates for the July 1980 to June 1981 period indicate that angling use exceeds 1.3 million man-days annually (Ritter 1981). Fishing represents an important source of revenue for the local area. However, salinity levels exceeding 40,000 mg/L are expected to seriously impact the natural reproduction and survival of the fishery resource (Hanson 1970; Lasker, Tenaza, and Chamberlain 1972; Brocksen and Cole 1972).

b. Terrestrial Communities. Only those terrestrial communities that could possibly be affected by the implementation of water conservation measures are addressed.

(1) Agricultural. Land use in the Imperial Valley is extensively agricultural. A wide range of crops is produced during the year within each of the following categories: apiary products, field crops, fruit and nut crops, livestock and dairy, seed and nursery crops, and vegetable crops.

(a) Vegetation. Ruderal, or weedy, vegetation occurs in undisturbed agricultural areas such as roadsides, field borders, canal banks, and railroad rights-of-way. Vegetation is generally restricted to "weedy" species such as pigweed, cheeseweed, shepherd's purse, saltbush, salt cedar, and various thistles and grasses. Growth is often controlled by mowing, burning, or through the use of herbicides. These weedy areas provide the only semi-permanent habitat remaining within agricultural areas.

(b) Wildlife. Amphibians and reptiles are restricted to border areas. Species include various lizards and snakes.

Birds use agricultural fields primarily as a food source. Over 210 species have been sighted in this habitat type (USFWS 1970). Common species include English sparrows, pigeons, brown-headed cowbirds, starlings, white-winged doves, and mourning doves. During the fall and winter, migrating waterfowl return to nearby refuges or continue their migrations after feeding. Local waterfowl return to protective shelters or roost sites located outside the agricultural areas. Hunters harvest significant numbers of doves and migrant waterfowl in the area.

Mammals are primarily restricted to ruderal areas. Border habitat supports round-tailed ground squirrels, various mice, and large, mobile mammals such as foxes, coyotes, badgers, skunks, jackrabbits, and raccoons.

(2) Canal, Lateral, and Surface Drain Riparian.

(a) Vegetation. Riparian growth is generally restricted to a 3- to 15-foot wide corridor running along canal shorelines. Common reed and saltgrass are usually found in dense stands near the water's edge and on canal banks. Vegetation rapidly decreases towards the tops of levees. Outer slope levee vegetation is often sparse and weedy. Representative plant species are comparable to those found in undisturbed agricultural areas.

Riparian vegetation such as baccharis, arrowweed, salt cedar, and occasional stands of cottonwood can sometimes be found adjacent to a canal, lateral, or surface drain. These areas of riparian vegetation are supported by seepage water.

(b) Wildlife. Wildlife diversity is heavily influenced by the type of vegetative community it transverses. Literature reviews and field investigations indicate that 17 species of amphibians and reptiles, 68 species of birds, and 20 species of mammals are associated with this terrestrial community (Engineering-Science 1980). Field investigations conducted by Engineering-Science (1980), however, only identified three species of amphibians commonly associated with this community: the bullfrog (*Rana catesbeiana*), woodhouse toad (*Bufo woodhousei*), and spiny soft-shell turtle (*Triony spiniferus*). The bullfrog and soft-shell turtle are harvested by sportsmen.

Bird use of this community varies with the type and amount of vegetation present. Some common species include the black phoebe, western Kingbird, and red-winged swallow. Waterfowl find food and cover in the vegetation. The burrowing owl, although declining in other areas, is common and nests along steep canal banks where vegetation is sparse. The declining status of the owl is exemplified by being included in the National Audubon Society's "Blue Listing Status."

Muskrats are the most conspicuous mammals. The round-tailed ground squirrel, kangaroo rat, southern pocket gopher, and deer mouse are also commonly found in short vegetation along canal banks.

(3) Alamo River and New River Riparian.

(a) Vegetation. The riparian communities of the Alamo and New Rivers represent most of the riparian habitat available in the Imperial Valley. Riparian vegetation is restricted in most areas to a 50- to 100-foot wide corridor due to extensive development of farmlands. Vegetation in many areas consists of extremely dense thickets of salt cedar, common reed, wing scale, and giant reed. Willow and cottonwood trees are found occasionally. Other common plant species include arrowweed, seepwillow, cattail, iodine bush, quailbush, and various agricultural-oriented weeds. Salt cedar is the dominant species.

Species diversity and density are determined by the availability of surface or subsurface water supplies. Phreatophyte species are dependent upon a permanent water source. Some species such as salt cedar and mesquite are deep-rooted and are more adaptable than shallow-rooted species like seepwillow and arrowweed.

(b) Wildlife. The importance of riparian habitat to wildlife is well documented. The riparian corridors of the Alamo and New Rivers, however, are considered to be of low to moderate quality wildlife habitat due to several factors. First, being constricted to a narrow band, the community is of limited areal extent. Second, dense thickets of salt cedar occupy a large percentage of each riparian corridor.

Third, such homogeneous thickets support fewer numbers and a lower diversity of species than native heterogenous riparian communities.

Despite the relatively low quality of these riparian habitats, these riparian corridors do provide important wildlife values. The abundance and diversity of bird life remain higher than in the surrounding desert and agricultural areas. A major nesting area is provided for mourning doves. Extremely important and extensively used migration avenues are provided. Cover, roosting, and nesting sites for many waterfowl species which feed in the adjacent agricultural areas are also provided.

The spiny soft-shell turtle has been reported in the Alamo and New Rivers. Although not reported, bullfrogs, toads, and other species may be present.

The Alamo and New River corridors apparently support few mammal species (Engineering-Science 1980). The deer mouse, cotton rat, and insectivore bat represent the majority of small mammals. Other species which apparently occur uncommonly include the muskrat, raccoon, grey fox, and coyote.

(4) Wetland. Three types of wetland exist in the Imperial Valley: (1) deltaic marshes; (2) riparian marshes and lakes; and (3) marshes maintained by seepage emanating from main canals.

Deltaic marshes exist where the Alamo River and New River, Salt Creek, and Jim Folger Creek empty into the Sea. The deltaic marshes of the Alamo and New Rivers are included in the Salton Sea National Wildlife Refuge. The deltaic marshes of the Alamo River are also included in the Hazard Unit of the Imperial Wildlife Area.

Due to the surface and subsurface irrigation return flows which enter the Sea and the inflows resulting from heavy storm runoff during the past 6 or 7 years from throughout the Basin, the elevation of the Sea has been rising. As a result, adjacent areas of the Salton Sea National Wildlife Refuge and the Hazard Unit have been inundated. Subsequently, wetland habitat has been lost. Additional wetland habitat areas remain vulnerable to further inundation.

Riparian marshes and lakes are concentrated along the Alamo River. Finney Lake and Ramer Lake are included in the Finney-Ramer Unit of the Imperial Wildlife Area. A number of gun and wildlife clubs manage some of these riparian areas for waterfowl hunting.

A number of marsh areas are maintained by seepage emanating along sections of the Coachella, East Highline, and All-American Canals. Most of these marsh areas measure less then 5 acres in area. A few marsh areas, however, are much larger. The largest and best developed marsh area in the Imperial Valley is located adjacent to the East Highline Canal Turnout on the All-American Canal.

(a) Vegetation. Species diversity and composition may vary depending upon local conditions. Cattails and common reed are the predominant species in most areas. Bushy plants such as seepwillow, salt cedar, arrowweed, and pampas grass may be found in "drier areas." In general, plant diversity in these wetlands is quite low (Engineering-Science 1980).

(b) Wildlife. Wetlands provide probably the most important wildlife habitat in terms of densities and species diversity in the area, especially for birds. Probably the most attractive bird habitats are those associated with the Salton Sea National Wildlife Refuge, the Imperial Wildlife Area, and the marsh area adjacent to the East Highline Canal Turnout. Five species of reptiles, at least 170 species of birds, and 27 species of mammals are associated with this community (Engineering-Science 1980).

Bullfrogs and leopard frogs are the most common amphibians found in the wetland community. Reptiles are generally absent or occur in low numbers. The western whiptail is the most common reptile.

Mammal trapping efforts by Engineering-Science (1980) showed that this habitat supported higher mammal densities than any other habitat type sampled. The cotton rat and brush mouse were found to be the most abundant species. Other species included the western harvest mouse, house mouse, and white-throated woodrat. The desert cottontail, raccoon, and coyote were also found to be present.

As with small mammals, bird densities were also found to be very high. Field studies conducted by Engineering-Science (1980) of Alamo River, Imperial Wildlife Area, and All-American Canal wetlands revealed breeding bird densities averaging an estimated 85, 312, and 737 pairs/100 acres, respectively. The high density for the All-American Canal study area was influenced by a colony of yellow-headed blackbirds.

C. Historical Narrative

The aboriginal occupation of the Imperial Valley was part of the extensive aboriginal trade network that extended up and down the Colorado River. The earliest well-documented use of the Colorado River was by the so-called San Diequito cultures. These cultures may date back several millennia. The occupation of the Imperial Valley was apparently determined by the periodic inflows of Colorado River water which created and recreated ancient Lake Cahuilla. During the times of Lake Cahuilla's existence, extensive occupation along the lake shore and surrounding slough areas took place. The latest of these occupations lasted until about four to five hundred years ago. Evidence of this latest shoreline appears as a band of dune-like areas which ring the Imperial Valley. The shoreline exhibits evidence of intensive aboriginal occupation in the form of camp and resource procurement areas. The East Highline Canal roughly parallels this old shoreline.

The historic aboriginal occupation of the Imperial Valley was by the Kamia and Cahuilla peoples. The life styles of these peoples was founded on the simple hunter-gatherer desert culture base. Historic documentation indicates Kamia occupation along the New River as evidenced by camps located about 6 miles southwest of El Centro. The Kamia hunted small game, deer, and bighorn sheep, fished, and gathered wild plants, but also took advantage of the available water resource to practice a limited form of agriculture.

"La Jornada de los Muertos," the "Journey of the Dead," is how the Spanish explorer Juan Bautista de Anza described his 18th century journey through what today is known as the Imperial Valley. Those who preceded him and those who followed also encountered the same hostile desert environment.

The lure of the California gold fields of 1849 drew thousands of people for the first time through the Colorado River crossings near present-day Needles, California, and Yuma, Arizona. A few of these fortune-seekers recognized the agricultural potential locked in the rich, but arid, soils of the desert valleys through which they passed.

The idea of reclaiming the desert wastes of the Imperial Valley with water exported from the Colorado River was perceived before the Civil War, but was not realized until 1901. Meanwhile, the lands of the great American Southwest were brought under the jurisdiction of the United States by the ratification of the Treaty of Guadaloupe Hidalgo on February 2, 1848, which concluded the war with Mexico, and the Gadsden Purchase of December 30, 1853.

In 1896, the California Development Company (C. D. Company) was formed to reclaim the Imperial Valley. Excavation of the Imperial Canal (Canal), sometimes referred to as the Alamo Canal, began in August 1900. Water exported from the Colorado River was received in the Imperial Valley in June 1901. About 1,500 acres of land were put into crops later that year.

The Canal was the first project to bring Colorado River water into the Imperial Valley for purposes of irrigation. The point of diversion and headworks were located near Pilot Knob about 100 yards north of the International Boundary with Mexico. The Canal ran in a southerly direction from the headworks to a point about four miles inside Mexico and parallel to the Colorado River. The Canal then ran in a westerly direction as it followed the Alamo River Channel, one of the Colorado River's overflow channels. The Canal reentered the United States east of present-day Calexico. The Alamo River terminated in the Sink. Altogether, about 60 miles of the Canal were located in Mexico.

Operation of the Canal, however, was difficult without upstream control of the Colorado River. To control silting of the headworks and Canal, almost constant dredging was required and, to provide protection from rampaging floods, extensive levee systems were constructed. However, with its main canal and levees located in Mexico, the Imperial Valley was afforded little security for its water supply and flood defense.

By the fall of 1904, heavy silting of the headworks and first four miles of the Canal forced the C. D. Company to construct a temporary bypass channel from the Colorado River directly to the point where the Canal turned westward. The bypass channel was not fitted with a control gate. During the winter of 1904-1905, heavy precipitation in the Gila River Basin produced a series of large floodflows which poured down the Gila River and into the Colorado. These floodflows finally breached the structures which had been hastily constructed in an attempt to plug the bypass channel. As a result, the Colorado changed course. For almost two years, the entire flow of the Colorado flowed through the bypass channel, the Canal, the Alamo River Channel, the New River Channel, and into the Sink. The result was the formation of the Sea. The Colorado was finally turned back into its original channel in February 1907.

Additional cycles of flood and drought, levee failures, siltation problems, and mounting expense prompted the formal organization of the District and appeals to the Federal government for assistance in formulating permanent solutions to river control and regulation. The District was organized in 1911 as a publically-owned subdivision of the State of California. The extensive studies of the Colorado River Basin conducted by the Federal government resulted in the construction of Hoover Dam and Powerplant and the All-American Canal System as authorized by the Boulder Canyon Project Act of 1928.

D. Socioeconomic Characteristics

1. Population Characteristics and Trends. The population of Imperial County is concentrated in El Centro, Brawley, and Calexico. El Centro is the county seat and serves as the trade center for the Imperial Valley.

Table 9 displays the historical and projected population characteristics of Imperial County. About 30 percent of the population lives in unincorporated areas. Since 1950, the population of Imperial County has increased at a pace slower than that recorded in the rest of southern California.

The Imperial County Planning Department (Department) furnished the projections for the year 2000. As individual community projections had not previously been calculated, the Department recommended applying the percent of a community's 1980 county population to the projected 2000 population.

Table 9
HISTORICAL AND PROJECTED
POPULATION CHARACTERISTICS
OF IMPERIAL COUNTY, CALIFORNIA
Water Conservation Opportunities
Imperial Irrigation District, California

	1960 1/	1980 1/	2000 2/	Percent Change 1960 to 1980	Percentage of 1980 County Population
Communities:					
Brawley	12,703	14,946	22,000	18	16
Calexico	7,992	14,412	21,000	80	15
Calipatria	2,548	2,636	4,000	3	3
El Centro	16,811	23,996	35,000	43	26
Holtville	3,080	4,399	6,000	43	5
Imperial	2,658	3,416	5,000	29	4
Westmorland	1,404	1,590	2,000	13	2
Unincorporated Imperial County	25,000	26,715	39,000	7	29
Imperial County	72,196	92,110	134,000	28	100

1/ 1960 and 1980 data from the U.S. Department of Commerce, Bureau of the Census.

2/ 2000 data from the Imperial County Planning Department.

Accordingly, Imperial County and every community reflect an approximate 45 percent projected increase between 1980 and 2000. This procedure was expected to produce low estimates for urban areas and high estimates for rural areas since urban areas have been growing at a faster pace.

2. Employment. Table 10 displays the industry employment trends by percentage of labor force in Imperial County for 1960, 1970, and 1980. The agricultural sector has undergone the most dramatic changes. These changes are attributable to the increasing mechanization of, and to the price fluctuations in, agricultural commodities. Unemployment in Imperial County in 1982 was estimated at 35 percent.

Table 10
INDUSTRY EMPLOYMENT TRENDS BY PERCENTAGE OF LABOR FORCE
IMPERIAL COUNTY, CALIFORNIA 1/
Water Conservation Opportunities
Imperial Irrigation District, California

Industry	1960	1970	1980
Agriculture	39	19	38
Mining	0	0	0
Construction	3	5	3
Manufacturing	6	7	5
Transportation, Communication, and Public Utilities	8	9	3
Trade Industries	18	24	18
Finance, Insurance, and Real Estate	2	3	2
Services	17	24	9
Government	7	9	22

1/ Data from the U.S. Department of Commerce, Bureau of the Census.

Table 11 displays additional socioeconomic facts and figures for Imperial County in 1980.

E. Existing Water and Related Resource Development

1. Irrigation Service Area. The District's irrigation service area of 1,062,290 acres is divided into the East Mesa, Imperial, Pilot Knob, and West Mesa Units as shown on Frontispiece Map No. 212-300-474. Only the Imperial Unit has been developed due to the lack of adequate water supplies.

The Imperial Unit consists of about 694,400 acres of which an average of about 458,000 acres were irrigated during the 1977 to 1980 study period. The unit is subdivided into the Brawley, Calipatria, El Centro-Calexico, Holtville, Imperial, and Westmorland Divisions.

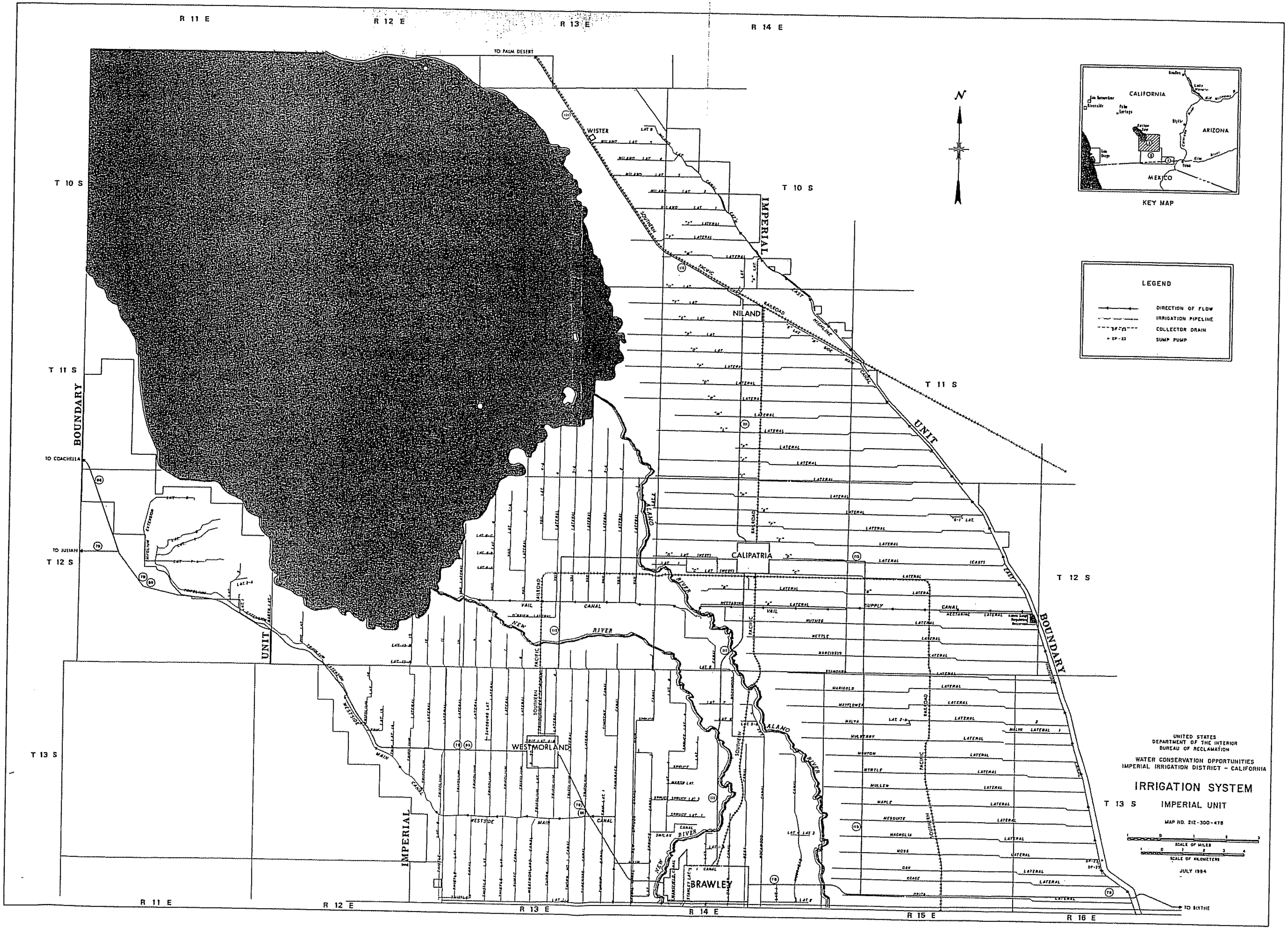
Table 11
SOCIOECONOMIC
FACTS AND FIGURES IN 1980,
IMPERIAL COUNTY, CALIFORNIA 1/
Water Conservation Opportunities
Imperial Irrigation District, California

Annual growth rate	2.3%
Percent of state population	0.4%
Percent Hispanic population	55.8%
Percent White population	38.3%
Civilian labor force	42,637
Percent of private land ownership	40.0%
Percent of government land ownership	60.0%
Industrial acreage	1,500
Median household effective buying income	$15,531

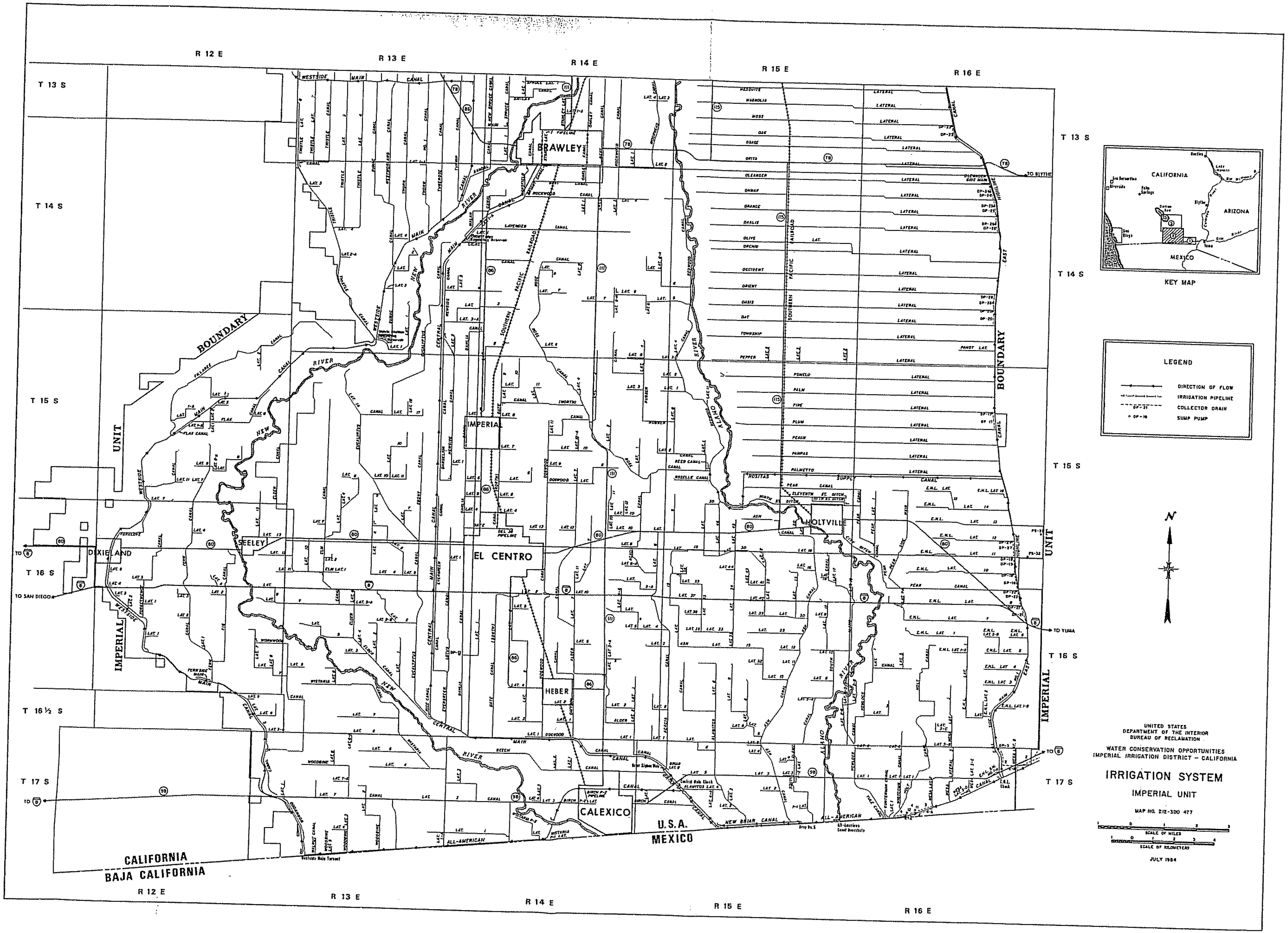
1/ Data from the County Administrative Office and the El Centro Chamber of Commerce.

2. Irrigation System. As of March 21, 1983, the District operated and maintained the California headworks, desilting basins, and sluiceway at Imperial Dam; the Check and Wasteway at Pilot Knob; the 80-mile All-American Canal; 1,625 miles of other main canals and laterals, of which about 840 miles have been concrete-lined; over 500 headgates; about 5,580 customer turnouts; four small regulating reservoirs; various checks, drops, and spillways; and Senator Wash Dam and Reservoir.

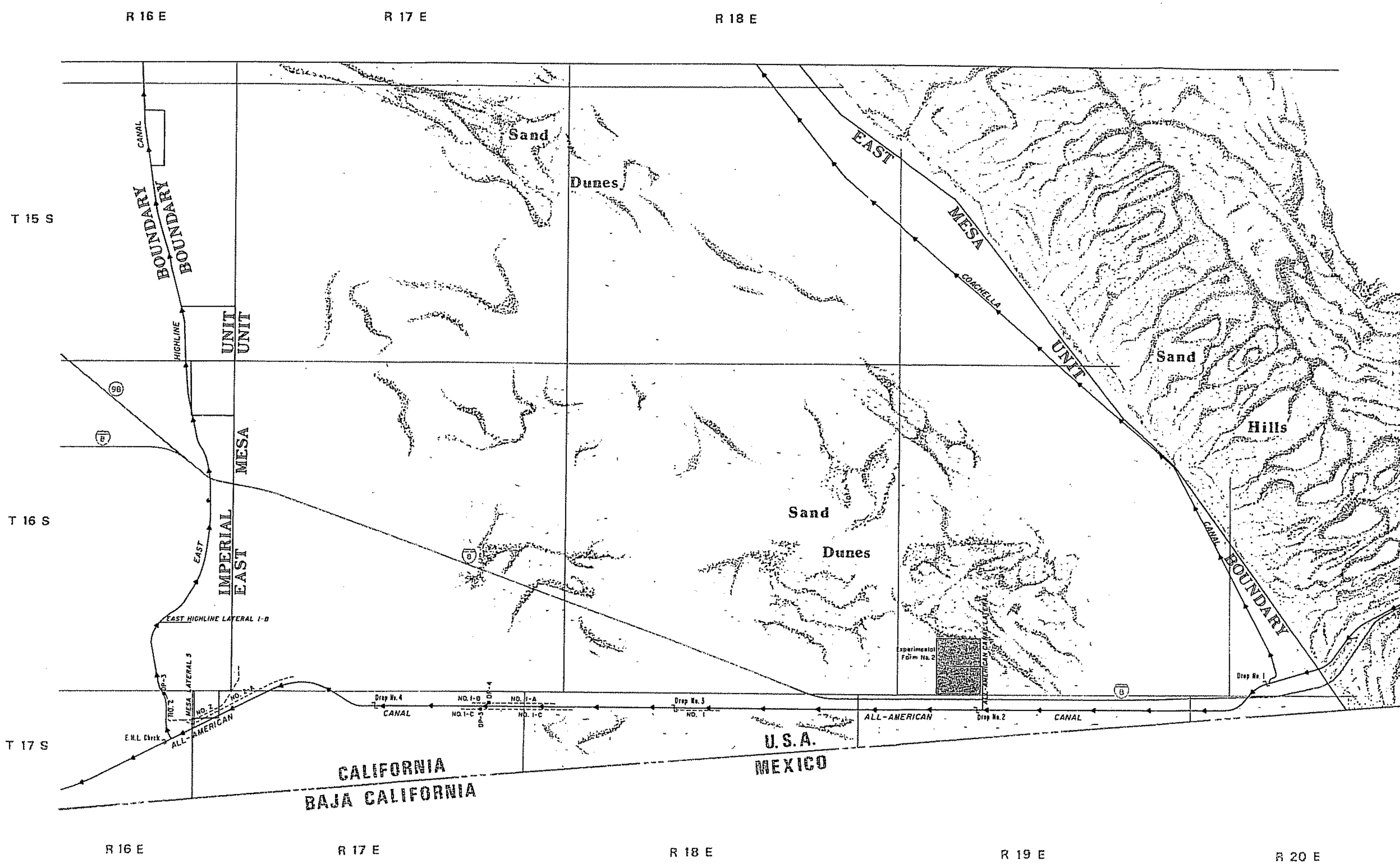
Water from the Colorado River is diverted at Imperial Dam through the headworks and desilting basins into the All-American Canal. Prior to arriving at Drop No. 1, some water is diverted to several canals serving the Reservation Division of the Yuma Project in California and the Valley Division of the Yuma Project in Arizona, and at times, through the Pilot Knob Powerplant with ultimate delivery to Mexico. Part of the remaining flow in the All-American Canal is diverted into the Coachella Canal at Drop No. 1 for delivery to agricultural customers in the Coachella Valley. The remaining flow is delivered to agricultural and M&I customers in the Imperial Valley. Drawings Nos. 212-300-476, 212-300-477, and 212-300-478 display the irrigation system of the Imperial Unit. An index of relevant irrigation system features follows.

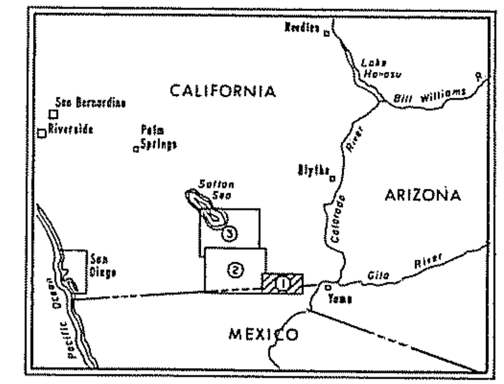


R 11 E
R 12 E
R 13 E
R 14 E
R 15 E
R 16 E
T 10 S
T 11 S
T 12 S
T 13 S
TO PALM DESERT
TO COACHILLA
TO JULIAN
TO BLYTHE
WISTER
NILAND
CALIPATRIA
WESTMORLAND
BRAWLEY
IMPERIAL UNIT BOUNDARY
EAST HIGHLINE CANAL
VAIL CANAL
VAIL SUPPLY CANAL
NEW RIVER
ALAMO RIVER
WESTSIDE MAIN CANAL
SOUTHERN PACIFIC RAILROAD
KEY MAP
CALIFORNIA
ARIZONA
MEXICO
LEGEND
DIRECTION OF FLOW
IRRIGATION PIPELINE
COLLECTOR DRAIN
SUMP PUMP
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WATER CONSERVATION OPPORTUNITIES
IMPERIAL IRRIGATION DISTRICT – CALIFORNIA
IRRIGATION SYSTEM
IMPERIAL UNIT
MAP NO. 212-300-478
SCALE OF MILES
SCALE OF KILOMETERS
JULY 1984



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WATER CONSERVATION OPPORTUNITIES
IMPERIAL IRRIGATION DISTRICT - CALIFORNIA
IRRIGATION SYSTEM
IMPERIAL UNIT
MAP NO. 212-300-477
SCALE OF MILES
SCALE OF KILOMETERS
JULY 1984
LEGEND
DIRECTION OF FLOW
IRRIGATION PIPELINE
COLLECTOR DRAIN
SUMP PUMP
KEY MAP
CALIFORNIA
ARIZONA
MEXICO
R 12 E
R 13 E
R 14 E
R 15 E
R 16 E
T 13 S
T 14 S
T 15 S
T 16 S
T 16½ S
T 17 S
BRAWLEY
IMPERIAL
EL CENTRO
HOLTVILLE
SEELEY
DIXIELAND
HEBER
CALEXICO
U.S.A.
MEXICO
CALIFORNIA
BAJA CALIFORNIA
IMPERIAL UNIT BOUNDARY
NEW RIVER
ALAMO RIVER
WESTSIDE MAIN CANAL
CENTRAL MAIN CANAL
EAST HIGHLINE CANAL
ALL-AMERICAN CANAL
SOUTHERN PACIFIC RAILROAD
TO SAN DIEGO
TO YUMA
TO BLYTHE





KEY MAP

LEGEND

- DIRECTION OF FLOW
- IRRIGATION PIPELINE
- NO. 1-C — COLLECTOR DRAIN
- • DP-4 — SUMP PUMP

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WATER-CONSERVATION OPPORTUNITIES
IMPERIAL IRRIGATION DISTRICT - CALIFORNIA

IRRIGATION SYSTEM

IMPERIAL UNIT

MAP NO. 212-300-476

SCALE OF MILES: 1 0 1 2 3

SCALE OF KILOMETERS: 1 0 1 2 3 4

JULY 1984

IMPERIAL IRRIGATION DISTRICT IRRIGATION SYSTEM INDEX
(Status as of December 31, 1980)

I. Watercourses

Watercourse	Division	Run
Acacia Canal	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 1	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 2	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 3	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 4, 4-A, 5	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 5-A	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 6	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 6-A	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 8	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 9	El Centro-Calexico	Acacia Zanjero
Acacia Lat. 10, 11, 12	El Centro-Calexico	Acacia Zanjero
Alamitos Canal	El Centro-Calexico	Acacia Zanjero
Alamitos Lat. 2	El Centro-Calexico	Acacia Zanjero
Alamitos Lat. 3	El Centro-Calexico	Acacia Zanjero
Alamitos Lat. 4, 4-A	El Centro-Calexico	Acacia Zanjero
Alamitos Lat. 5	El Centro-Calexico	Acacia Zanjero
Alamitos Lat. 6	El Centro-Calexico	Acacia Zanjero
Alamitos Lat. 8	El Centro-Calexico	Acacia Zanjero
Alder Canal	El Centro-Calexico	Acacia Zanjero
Alder Lat. 1	El Centro-Calexico	Acacia Zanjero
Alder Lat. 2, 3	El Centro-Calexico	Acacia Zanjero
Alder Lat. 5, 5-A	El Centro-Calexico	Acacia Zanjero
Alder Lat. 6	El Centro-Calexico	Acacia Zanjero
Alder Lat. 7, 10, 11	El Centro-Calexico	Acacia Zanjero
Alder Lat. 12	El Centro-Calexico	Acacia Zanjero
All-American Canal	Holtville	All-American Hydrographer
All-American Canal	El Centro-Calexico	All-American Hydrographer
All-American Canal Lateral 7	Holtville	All-American Hydrographer
Ash Canal	Holtville	Ash Main Zanjero
Ash Lat. 2	Holtville	Ash Main Zanjero
Ash Lat. 3	Holtville	Ash Main Zanjero
Ash Lat. 4	Holtville	Ash Main Zanjero
Ash Lat. 5	Holtville	Ash Main Zanjero
Ash Lat. 6, 8, 9	Holtville	Ash Main Zanjero
Ash Lat. 11	Holtville	Ash Main Zanjero
Ash Lat. 12	Holtville	Ash Main Zanjero
Ash Lat. 13	Holtville	Ash Main Zanjero
Ash Lat. 15	Holtville	Ash Main Zanjero
Ash Lat. 15, 32	Holtville	Ash Main Zanjero
Ash Lat. 16	Holtville	Ash Main Zanjero
Ash Lat. 18	Holtville	Ash Main Zanjero

Watercourse	Division	Run
Ash Lat. 20	Holtville	Ash Main Zanjero
Ash Lat. 25	Holtville	Ash Main Zanjero
Ash Lat. 30	Holtville	Ash Main Zanjero
Ash Lat. 30, 39, 40, 41, 42, 43, 45, 46	Holtville	Ash 15-30 Zanjero
Ash Lat. 33, 35, 36, 37, 38	Holtville	Ash 15-30 Zanjero
Ash Lat. 34, 44	Holtville	Ash 15-30 Zanjero
"B" Lateral	Calipatria	Nectarine Zanjero
Barth Lat.	Westmorland	Trifolium Extension Zanjero
Beech Canal	El Centro-Calexico	Alder Zanjero
Beech Lat. 1	El Centro-Calexico	Alder Zanjero
Beech Lat. 2	El Centro-Calexico	Alder Zanjero
Best Canal	Brawley	Bryant Zanjero
Birch Canal	El Centro-Calexico	All-American Hydrographer
Birch Lat. 1	El Centro-Calexico	All-American Hydrographer
Birch Lateral 3	El Centro-Calexico	All-American Hydrographer
Birch Lat. 4	El Centro-Calexico	All-American Hydrographer
Birch P-2 Lateral	El Centro-Calexico	All-American Hydrographer
Birch P-2 Pipeline	El Centro-Calexico	All-American Hydrographer
Briar Canal	El Centro-Calexico	All-American Hydrographer
Briar Lat. 8	El Centro-Calexico	All-American Hydrographer
Bryant Canal	Brawley	Bryant Zanjero
"C" Lateral	Calipatria	"C" Zanjero
"C" Lat. (West)	Calipatria	Nectarine Zanjero
"C" Lat. (West) Lat. 1	Calipatria	Nectarine Zanjero
Central Main Canal	El Centro-Calexico	All-American Hydrographer
Central Main Canal	El Centro-Calexico	Double Weir Hydrographer
Central Main Canal	Imperial	Rice & Central Main Hydrographer
Central Main Canal	Brawley	Central Main Hydrographer
City Ditch	Holtville	Pear Zanjero
"D" Lateral (East)	Calipatria	"C" Zanjero
"D" Lat. (West)	Calipatria	Nectarine Zanjero
"D" Lat. (West) Pipeline	Calipatria	Nectarine Zanjero
Daffodil Canal	El Centro-Calexico	Dogwood Zanjero
Daffodil Lat. 1	El Centro-Calexico	Dogwood Zanjero
Daffodil Lat. 2	El Centro-Calexico	Dogwood Zanjero
Daffodil Lat. 2 Pipeline	El Centro-Calexico	Dogwood Zanjero
Dahlia Canal	Imperial	Dahlia Zanjero
Dahlia Canal Pipeline	Imperial	Dahlia Zanjero
Dahlia Lat. 1	Imperial	Dahlia Zanjero
Dahlia Lat. 4	Imperial	Dahlia Zanjero
Dahlia Lat. 5	Imperial	Dahlia Zanjero
Dahlia Lat. 6	Imperial	Dahlia Zanjero
Dahlia Lat. 8	Imperial	Dahlia Zanjero

Watercourse	Division	Run
Dandelion Canal	Imperial	Evergreen Zanjero
Date Canal (North)	Imperial	Dahlia Zanjero
Date Canal (South)	El Centro-Calexico	Dogwood Zanjero
Date Canal Pipeline	Imperial	Dahlia Zanjero
Date Lat. 4	Imperial	Dahlia Zanjero
Date Lat. 5	Imperial	Dahlia Zanjero
Date Lat. 6	Imperial	Dahlia Zanjero
Date Lat. 7	Imperial	Dahlia Zanjero
Date Lat. 8	Imperial	Dahlia Zanjero
Date Lat. 9, 10	Imperial	Dahlia Zanjero
Date Lat. 11	Imperial	Dahlia Zanjero
Del 36 Pipeline	Imperial	Dahlia Zanjero
Dogwood Canal	El Centro-Calexico	Dogwood Zanjero
Dogwood Lat. 1	El Centro-Calexico	Dogwood Zanjero
Dogwood Lat. 2, 3, 4, 5	El Centro-Calexico	Dogwood Zanjero
Dogwood Lat. 6, 7	El Centro-Calexico	Dogwood Zanjero
Dogwood Lat. 9	El Centro-Calexico	Dogwood Zanjero
Dogwood Lat. 10, 10-A	El Centro-Calexico	Dogwood Zanjero
Dogwood Lat. 11	El Centro-Calexico	Dogwood Zanjero
Dogwood Lat. 13	El Centro-Calexico	Dogwood Zanjero
"E" Lateral	Calipatria	"C" Zanjero
East Highline Canal	Holtville	East Highline Hydrographer
East Highline Canal	Holtville	East Highline Hydrographer
East Highline Lat. 1, 1-A, 2	Holtville	Holt Zanjero
East Highline Lateral 1-B	Holtville	East Highline Hydrographer
East Highline Lat. 3	Holtville	Holt Zanjero
East Highline Lat. 4	Holtville	Holt Zanjero
East Highline Lateral 5	Holtville	East Highline Hydrographer
East Highline Lat. 5-B	Holtville	East Highline Hydrographer
East Highline Lateral 6	Holtville	East Highline Hydrographer
East Highline Lateral 7	Holtville	Pear Zanjero
East Highline Lat. 7-A	Holtville	Pear Zanjero
East Highline Lateral 8	Holtville	Pear Zanjero
East Highline Lateral 10	Holtville	Pear Zanjero
East Highline Lateral 11	Holtville	Palmetto Zanjero
East Highline Lateral 12	Holtville	Palmetto Zanjero
East Highline Lateral 13	Holtville	Palmetto Zanjero
East Highline Lateral 14	Holtville	Palmetto Zanjero
East Highline Lat. 15	Holtville	Palmetto Zanjero
East Highline Lateral 16	Holtville	Palmetto Zanjero
East Highline Side Main No. 1	Holtville	Holt Zanjero
East Highline Side Main No. 1-A	Holtville	Holt Zanjero
Ebony Canal	Imperial	Eucalyptus Zanjero
Elder Canal	Imperial	Elder Zanjero
Elder Lat. 1	Imperial	Elder Zanjero

Watercourse	Division	Run
Elder Lat. 2	Imperial	Elder Zanjero
Elder Lat. 3	Imperial	Elder Zanjero
Elder Lat. 4	Imperial	Elder Zanjero
Elder Lat. 5	Imperial	Elder Zanjero
Elder Lat. 5-A	Imperial	Elder Zanjero
Elder Lat. 6	Imperial	Elder Zanjero
Elder Lat. 7, 8	Imperial	Elder Zanjero
Elder Lat. 10	Imperial	Elder Zanjero
Elder Lat. 11	Imperial	Elder Zanjero
Elder Lat. 12	Imperial	Elder Zanjero
Elder Lat. 13	Imperial	Elder Zanjero
Eleventh Street Ditch	Holtville	Pear Zanjero
Elm Canal	Imperial	Elder Zanjero
Elm Lat. 1	Imperial	Elder Zanjero
Elm Lat. 2	Imperial	Elder Zanjero
Elm Lat. 3, 4, 6	Imperial	Elder Zanjero
Elm Lat. 7	Imperial	Elder Zanjero
Evergreen Canal	Imperial	Evergreen Zanjero
Eucalyptus Canal	Imperial	Ecalyptus Zanjero
Eucalyptus Lat. 2, 2-B	Imperial	Ecalyptus Zanjero
Eucalyptus Lat. 4, 5	Imperial	Ecalyptus Zanjero
Eucalyptus Lat. 7	Imperial	Ecalyptus Zanjero
Eucalyptus Lat. 10, 11	Imperial	Ecalyptus Zanjero
Eucalyptus Lat. 14	Imperial	Ecalyptus Zanjero
Eucalyptus Lat. 17, 18	Imperial	Ecalyptus Zanjero
"F" Lateral	Calipatria	"C" Zanjero
Fern Canal	Imperial	Fern Zanjero
Fern Lat. 1	Imperial	Fern Zanjero
Fern Lat. 2	Imperial	Fern Zanjero
Fern Lat. 3	Imperial	Fern Zanjero
Fern Lat. 4	Imperial	Fern Zanjero
Fern Lat. 7	Imperial	Fern Zanjero
Fern Lat. 8, 8-A	Imperial	Fern Zanjero
Fern Lat. 9	Imperial	Fern Zanjero
Fern Side Main	Imperial	Fern Zanjero
Fig Canal	Imperial	Fern Zanjero
Fig Lat. 2	Imperial	Fern Zanjero
Fig Lat. 4	Imperial	Fern Zanjero
Fillaree Canal	Imperial	Foxglove Zanjero
Fillaree Lat. 1	Imperial	Foxglove Zanjero
Fillaree Lat. 1-A	Imperial	Foxglove Zanjero
Fillaree Lat. 2	Imperial	Foxglove Zanjero
Flax Canal	Imperial	Foxglove Zanjero
Flax Lat. 1	Imperial	Foxglove Zanjero
Flax Lat. 1-A	Imperial	Foxglove Zanjero
Flax Lat. 2, 3	Imperial	Foxglove Zanjero
Flax Lat. 6	Imperial	Foxglove Zanjero
Forgetmenot Canal	Imperial	Foxglove Zanjero

Watercourse	Division	Run
Forgetmenot Lat. 1	Imperial	Foxglove Zanjero
Forgetmenot Lat. 3	Imperial	Foxglove Zanjero
Foxglove Canal	Imperial	Foxglove Zanjero
Foxglove Lat. 1	Imperial	Foxglove Zanjero
Foxglove Lat. 2	Imperial	Foxglove Zanjero
Foxglove Lat. 3	Imperial	Foxglove Zanjero
Foxglove Lat. 4	Imperial	Foxglove Zanjero
Foxglove Lat. 5	Imperial	Foxglove Zanjero
Foxglove Lat. 7	Imperial	Foxglove Zanjero
Foxglove Lat. 11	Imperial	Foxglove Zanjero
"G" Lateral	Calipatria	"C" Zanjero
"G-1" Lat.	Calipatria	"C" Zanjero
"G" Lat. 2	Calipatria	"C" Zanjero
Gunterman Canal	Holtville	South Alamo Zanjero
Gunterman Lat. 1	Holtville	South Alamo Zanjero
"H" Lateral	Calipatria	"H" Zanjero
Hemlock Canal	Holtville	South Alamo Zanjero
Hemlock Lat. 1	Holtville	South Alamo Zanjero
Hemlock Lat. 2	Holtville	South Alamo Zanjero
Hemlock Lat. 2-B, 2-D	Holtville	South Alamo Zanjero
Hemlock Lat. 3	Holtville	South Alamo Zanjero
Hemlock Lat. 4	Holtville	South Alamo Zanjero
Hemlock Lat. 5	Holtville	South Alamo Zanjero
Holt Canal	Holtville	Holt Zanjero
Holt Lat. 1	Holtville	Holt Zanjero
"I" Lateral	Calipatria	"H" Zanjero
"J" Lateral	Calipatria	"H" Zanjero
"K" Lateral	Calipatria	"H" Zanjero
"L" Lateral	Calipatria	"H" Zanjero
Lavender Canal	Brawley	Bryant Zanjero
Lavender Lat. 1	Brawley	Bryant Zanjero
Lavender Lat. 1-A	Brawley	Bryant Zanjero
Lilac Canal	Brawley	Bryant Zanjero
Lotus Canal	Imperial	Evergreen Zanjero
Lotus Lat. 1	Imperial	Evergreen Zanjero
"M" Lateral	Calipatria	Side Main Zanjero
Magnolia Lateral	Brawley	Oleander Zanjero
Main Spruce Canal	Westmorland	Spruce Zanjero
Malan Canal	Brawley	Bryant Zanjero
Malva Lateral 1	Brawley	Mayflower Zanjero
Malva Lateral 2	Brawley	Mayflower Zanjero
Malva Lat. 2-A	Brawley	Mayflower Zanjero
Mansfield Canal	Brawley	Bryant Zanjero

Watercourse	Division	Run
Mansfield Canal Pipeline	Brawley	Bryant Zanjero
Maple Lateral	Brawley	Myrtle Zanjero
Marigold Lateral	Brawley	Mayflower Zanjero
Marsh Lat.	Westmorland	Spruce Zanjero
Mayflower Lateral	Brawley	Mayflower Zanjero
Mesa Lateral 2	Holtville	Holt Zanjero
Mesa Lateral 3	Holtville	Holt Zanjero
Mesa Lat. 3-B	Holtville	Holt Zanjero
Mesa Lat. 3-C	Holtville	Holt Zanjero
Mesa Lateral 3-D	Holtville	Holt Zanjero
Mesa Lat. 3-E	Holtville	Holt Zanjero
Mesa Lateral 5	Holtville	East Highline Hydrographer
Mesquite Lateral	Brawley	Myrtle Zanjero
Moorhead Canal	Brawley	Rockwood Zanjero
Moorhead Lat. 1	Brawley	Rockwood Zanjero
Moorhead Lat. 2	Brawley	Rockwood Zanjero
Moorhead Lat. 3	Brawley	Rockwood Zanjero
Moorhead Lat. 4	Brawley	Rockwood Zanjero
Moss Lateral	Brawley	Oleander Zanjero
Mulberry Lateral	Brawley	Mayflower Zanjero
Mullen Lateral	Brawley	Myrtle Zanjero
Munyon Lateral	Brawley	Myrtle Zanjero
Myrtle Lateral	Brawley	Myrtle Zanjero
"N" Lateral	Calipatria	Side Main Zanjero
Narcissus Lateral	Calipatria	Nectarine Zanjero
Nectarine "A" Lat.	Calipatria	Nectarine Zanjero
Nectarine Lateral	Calipatria	Nectarine Zanjero
Nettle Lateral	Calipatria	Nectarine Zanjero
New Briar Canal	El Centro-Calexico	New Briar Hydrographer
Newside Canal	Imperial	Evergreen Zanjero
Newside Lat. 1	Imperial	Evergreen Zanjero
Newside Lat. 2	Imperial	Evergreen Zanjero
Newside Lat. 3, 3-A	Imperial	Evergreen Zanjero
Newside Lat. 4	Imperial	Evergreen Zanjero
Newside Lat. 5	Imperial	Evergreen Zanjero
New Spruce Canal	Westmorland	Spruce Zanjero
Niland Lat. Canal Extension	Calipatria	"Z" Zanjero
Niland Lat. 1	Calipatria	"Z" Zanjero
Niland Lat. 2	Calipatria	"Z" Zanjero
Niland Lat. 3	Calipatria	"Z" Zanjero
Niland Lat. 4	Calipatria	"Z" Zanjero
Niland Lat. 5	Calipatria	"Z" Zanjero
Niland Lat. 6	Calipatria	"Z" Zanjero
Ninth Street Ditch	Holtville	Pear Zanjero
Ninth Street Ditch Pipeline	Holtville	Pear Zanjero
Nutmeg Lateral	Calipatria	Nectarine Zanjero

Watercourse	Division	Run
"O" Lateral	Calipatria	Side Main Zanjero
Oak Lateral	Brawley	Oleander Zanjero
Oakley Canal	Brawley	Bryant Zanjero
Oakley Canal Pipeline	Brawley	Bryant Zanjero
Oasis Lateral	Holtville	Oat Zanjero
Oat Lateral	Holtville	Oat Zanjero
O'Brien Lateral	Calipatria	West Vail Hydrographer
Occident Lateral	Holtville	Oat Zanjero
Ohmar Lateral	Brawley	Orange Zanjero
Oleander Lateral	Brawley	Oleander Zanjero
Oleander Side Main	Brawley	Oleander Zanjero
Olive Lat.	Brawley	Orange Zanjero
Orange Lateral	Brawley	Orange Zanjero
Orchid Lateral	Brawley	Orange Zanjero
Orient Lateral	Holtville	Oat Zanjero
Orita Lateral	Brawley	Oleander Zanjero
Osage Lateral	Brawley	Oleander Zanjero
Oxalis Lateral	Brawley	Orange Zanjero
"P" Lateral	Calipatria	Side Main Zanjero
Palm Lateral	Holtville	Pomelo Zanjero
Palmetto Lateral	Holtville	Palmetto Zanjero
Pampas Lateral	Holtville	Palmetto Zanjero
Pansy Lateral	Holtville	East Highline Hydrographer
Peach Lateral	Holtville	Palmetto Zanjero
Pear Canal	Holtville	Pear Zanjero
Pear Lat. 1	Holtville	Pear Zanjero
Pear Side Main	Holtville	Pear Zanjero
Pepper Lateral	Holtville	Pomelo Zanjero
Pepper Lat. 2, 3, 5	Holtville	Pomelo Zanjero
Pine Lateral	Holtville	Pomelo Zanjero
Plum Lateral	Holtville	Pomelo Zanjero
Poe Lat.	Westmorland	Trifolium Extension Zanjero
Pomelo Lateral	Holtville	Pomelo Zanjero
"Q" Lat.	Calipatria	Side Main Zanjero
"R" Lat.	Calipatria	Side Main Zanjero
"R" Side Main	Calipatria	Side Main Zanjero
Redwood Canal	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 1	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 2	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 3	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 4	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 5, 6	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 5-A, 7	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 8, 8-A	El Centro-Calexico	Rositas System Zanjero
Redwood Lat. 11	El Centro-Calexico	Rositas System Zanjero

Watercourse	Division	Run
Reed Canal	El Centro-Calexico	Rositas System Zanjero
Rice Canal	Imperial	Rice & Central Main Hydrographer
Rockwood Canal	Brawley	Rockwood Zanjero
Rockwood Lat. 1	Brawley	Rockwood Zanjero
Rockwood Lat. 2	Brawley	Rockwood Zanjero
Rockwood Lat. 3	Brawley	Rockwood Zanjero
Rockwood Lat. 4	Brawley	Rockwood Zanjero
Rockwood Lat. 5, 5-A	Brawley	Rockwood Zanjero
Rockwood Lat. 6	Brawley	Rockwood Zanjero
Rockwood Lat. 7	Brawley	Rockwood Zanjero
Rockwood Lat. 8	Brawley	Rockwood Zanjero
Rose Canal	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 1	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 2	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 3	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 4	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 6	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 7	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 8	El Centro-Calexico	Rositas System Zanjero
Rose Lat. 9	El Centro-Calexico	Rositas System Zanjero
Roselle Canal	El Centro-Calexico	Rositas System Zanjero
Rositas Supply Canal	Holtville	Rositas Hydrographer
Rubber Canal	El Centro-Calexico	Rositas System Zanjero
Rubber Lat. 1	El Centro-Calexico	Rositas System Zanjero
Rubber Lat. 2	El Centro-Calexico	Rositas System Zanjero
Rubber Lat. 3	El Centro-Calexico	Rositas System Zanjero
Rubber Lat. 4, 5	El Centro-Calexico	Rositas System Zanjero
Rubber Lat. 6	El Centro-Calexico	Rositas System Zanjero
"S" Lat.	Calipatria	Side Main Zanjero
Sandal Canal	Westmorland	Spruce Zanjero
Sandal Lat. 1	Westmorland	Spruce Zanjero
Sandburg Lat.	Westmorland	Trifolium Lateral 4 Zanjero
Smilax Canal	Westmorland	Spruce Zanjero
Smilax Lat. 1	Westmorland	Spruce Zanjero
South Alamo Canal	Holtville	South Alamo Zanjero
South Alamo Lat. 3	Holtville	South Alamo Zanjero
South Alamo Lat. 4	Holtville	South Alamo Zanjero
South Alamo Lat. 5-A	Holtville	South Alamo Zanjero
South Alamo Lat. 6	Holtville	South Alamo Zanjero
South Alamo Lat. 10, 11, 12	Holtville	South Alamo Zanjero
South Alamo Lat. 16	Holtville	South Alamo Zanjero
South Alamo Lat. 17	Holtville	South Alamo Zanjero
South Alamo Lat. 18	Holtville	South Alamo Zanjero
South Alamo P-1 Lat.	Holtville	South Alamo Zanjero
South Alamo P-2 Lat.	Holtville	South Alamo Zanjero
Spruce Lat. 1	Westmorland	Spruce Zanjero

Watercourse	Division	Run
Spruce Lat. 3	Westmorland	Spruce Zanjero
Spruce Lat. 4, 5, 6	Westmorland	Spruce Zanjero
Standard Lateral	Brawley	Mayflower Zanjero
Stanley Lat. 1, 1-A	Brawley	Bryant Zanjero
Stanley Lat. 1 Pipeline	Brawley	Bryant Zanjero
Sumac Canal	Westmorland	Thistle Zanjero
Sumac Lat. 1	Westmorland	Thistle Zanjero
Sumac Lat. 2	Westmorland	Thistle Zanjero
Sumac Lateral 3	Westmorland	Thistle Zanjero
Sumac Lat. 4	Westmorland	Thistle Zanjero
"T" Lat.	Calipatria	"Z" Zanjero
Tamarack Canal	Westmorland	Tuberose Zanjero
Tenth Street Ditch	Holtville	Pear Zanjero
Thistle Canal	Westmorland	Thistle Zanjero
Thistle Lat. 2-A	Westmorland	Thistle Zanjero
Thistle Lat. 3	Westmorland	Thistle Zanjero
Thistle Lat. 4, 5	Westmorland	Thistle Zanjero
Thistle Lat. 7	Westmorland	Thistle Zanjero
Thistle Lat. 8	Westmorland	Thistle Zanjero
Thorn Canal	Westmorland	Tuberose Zanjero
Thorn No. 1 Canal	Westmorland	Tuberose Zanjero
Thorn No. 1 Canal Lat. 1-A	Westmorland	Tuberose Zanjero
Timothy Canal	Westmorland	Tuberose Zanjero
Township Canal	Holtville	Oat Zanjero
Trifolium Extension	Westmorland	Trifolium Extension Zanjero
Trifolium Extension Lat. 1	Westmorland	Trifolium Extension Zanjero
Trifolium Ext. Lat 2, 2-A	Westmorland	Trifolium Extension Zanjero
Trifolium Extension Lat. 7, 8	Westmorland	Trifolium Extension Zanjero
Trifolium Extension Lat. 7-A	Westmorland	Trifolium Extension Zanjero
Trifolium Extension Lat. 9	Westmorland	Trifolium Extension Zanjero
Trifolium Lateral 1	Westmorland	Tuberose Zanjero
Trifolium Lateral 2	Westmorland	Tuberose Zanjero
Trifolium Lateral 3	Westmorland	Tuberose Zanjero
Trifolium Lateral 4	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lat. 4-A	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lat. 5 North	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 5 South	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 6	Westmorland	Trifolium Lateral 4 Zanjero

Watercourse	Division	Run
Trifolium Lateral 7	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 8	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 9	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 10	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 11	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 12	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 13	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lat. 13-A	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lat. 13-B	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 14	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 15	Westmorland	Trifolium Lateral 4 Zanjero
Trifolium Lateral 16	Westmorland	Trifolium Lateral 4 Zanjero
Tuberose Canal	Westmorland	Tuberose Zanjero
Turnip Canal	Westmorland	Tuberose Zanjero
"U" Lat.	Calipatria	"Z" Zanjero
Vail Canal	Calipatria	West Vail Hydrographer
Vail Lateral 1	Calipatria	East Vail Zanjero
Vail Lateral 2	Calipatria	East Vail Zanjero
Vail Lateral 2-A	Calipatria	East Vail Zanjero
Vail Lateral 3	Calipatria	East Vail Zanjero
Vail Lateral 3-A	Calipatria	East Vail Zanjero
Vail Lat. 4	Calipatria	East Vail Zanjero
Vail Lateral 4-A	Calipatria	East Vail Zanjero
Vail Lateral 5	Calipatria	East Vail Zanjero
Vail Lateral 5-A	Calipatria	East Vail Zanjero
Vail Lateral 6	Calipatria	West Vail Hydrographer
Vail Lat. 6-A	Calipatria	West Vail Hydrographer
Vail Lat. 6-B	Calipatria	West Vail Hydrographer
Vail Lat. 6-C	Calipatria	West Vail Hydrographer
Vail Lateral 7	Calipatria	West Vail Hydrographer
Vail Supply Canal	Calipatria	West Vail Hydrographer
"W" Lateral	Calipatria	"Z" Zanjero
Walnut Canal	El Centro-Calexico	All-American Hydrographer
Westmorland Canal	Westmorland	Thistle Zanjero
Westside Main Canal	El Centro-Calexico	Westside Main Hydrographer
Westside Main Canal	Imperial	Westside Main Hydrographer

Watercourse	Division	Run
Westside Main Canal	Westmorland	Westside Main Hydrographer
Whitcomb Canal	Holtville	Holt Zanjero
Whitcomb Lat. 1	Holtville	Holt Zanjero
Whitcomb Lat. 2	Holtville	Holt Zanjero
Wistaria Canal	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 1, 1-A	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 2	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 3	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 4	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 5	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 6, 6-A	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 7	El Centro-Calexico	Wistaria Zanjero
Wistaria Lat. 8	El Centro-Calexico	Wistaria Zanjero
Wistaria P-1 Lateral	El Centro-Calexico	Wistaria Zanjero
Wistaria P-2 Lateral	El Centro-Calexico	Wistaria Zanjero
Woodbine Canal	El Centro-Calexico	Woodbine Zanjero
Woodbine Lateral 2	El Centro-Calexico	Woodbine Zanjero
Woodbine Lateral 3	El Centro-Calexico	Woodbine Zanjero
Woodbine Lat. 4	El Centro-Calexico	Woodbine Zanjero
Woodbine Lateral 5	El Centro-Calexico	Woodbine Zanjero
Woodbine Lat. 7	El Centro-Calexico	Woodbine Zanjero
Woodbine Lat. 7-A	El Centro-Calexico	Woodbine Zanjero
Woodbine Lat. 8	El Centro-Calexico	Woodbine Zanjero
Wormwood Canal	El Centro-Calexico	Woodbine Zanjero
Wormwood Lat. 1	El Centro-Calexico	Woodbine Zanjero
Wormwood Lat. 3, 3-A, 4, 5	El Centro-Calexico	Woodbine Zanjero
Wormwood Lat. 7, 8	El Centro-Calexico	Woodbine Zanjero
Wormwood Lat. 9	El Centro-Calexico	Woodbine Zanjero
"X" Lateral	Calipatria	"Z" Zanjero
"X" Lateral Pipeline	Calipatria	"Z" Zanjero
"Y" Lateral	Calipatria	"Z" Zanjero
Yule Canal	Holtville	South Alamo Zanjero
"Z" Lateral	Calipatria	"Z" Zanjero

II. Canal Seepage Recovery System

Location: All-American Canal beginning below Drop No. 1 and ending at the East Highline Check.

Canal Seepage Collector Drain	Sump Pump
All-American Collector Drain No. 1	None
All-American Collector Drain No. 1-A	DP-4
All-American Collector Drain No. 1-B	DP-4
All-American Collector Drain No. 1-C	DP-5

Location: All-American Canal beginning below the East Highline Check and ending at the Central Main Check.

Canal Seepage Collector Drain	Sump Pump
All-American Collector Drain No. 3	DP-11
All-American Collector Drain No. 4	DP-11
All-American Collector Drain No. 4	DP-12
All-American Collector Drain No. 4-A	DP-6

Location: East Highline Canal beginning at the East Highline Canal Turnout and ending at the Moss Lateral Turnout.

Canal Seepage Collector Drain	Sump Pump
All-American Collector Drain No. 2	DP-3
All-American Collector Drain No. 2-A	None
DP-21 Collector Drain	DP-21
DP-22 Collector Drain	DP-22
DP-18 Collector Drain	DP-18
DP-19 Collector Drain	DP-19
DP-27 Collector Drain	DP-27
None	PS-32
None	PS-21
DP-17 Collector Drain	DP-17
DP-20 Collector Drain	DP-20
DP-28 Collector Drain	DP-28
DP-26 Collector Drain	DP-26

Canal Seepage Collector Drain	Sump Pump
DP-25 Collector Drain	DP-25
DP-24 Collector Drain	DP-24
DP-23 Collector Drain	DP-23

Location: Imperial Division, Dahlia Zanjero Run, Dahlia Canal, near the Dahlia Lat. 1 Turnout.

Canal Seepage Collector Drain	Sump Pump
None	DP-13

III. Regulating Reservoirs

Location: Calipatria Division, Nectarine Zanjero Run, East Highline Canal between the Nutmeg Lateral and the Nectarine Lateral.

Kakoo Singh Regulating Reservoir

Location: Westmorland Division, Thistle Zanjero Run, between the Westside Main Canal and the Sumac Canal.

Melvin Sheldon Regulating Reservoir

Location: Brawley Division, Bryant Zanjero Run, Central Main Canal between the Lilac Canal and Lavender Canal Lat. 1.

Oscar Fudge Regulating Reservoir*

* Constructed in 1982.

About 56.5 miles, 63 miles, and 68 miles, downstream from Imperial Dam, flows are diverted into the East Highline Canal, the New Briar Canal, and the Central Main Canal, respectively. About 80 miles downstream at the terminous of the All-American Canal, the remaining flow is diverted into the Westside Main Canal. Additional flows are also diverted into laterals and customer turnouts at various locations along the All-American Canal, including the laterals and customer turnouts above the East Highline Canal.

The design capacity of the All-American Canal at Imperial Dam is 15,155 cubic feet per second (cfs). Due to downstream diversions at Siphon Drop and Pilot Knob, the capacity is reduced to 10,155 cfs above Drop No. 1. Below Drop No. 1, the capacity is 7,600 cfs. Additional diversions gradually reduce the capacity to 2,655 cfs at the Westside Main Canal Turnout. The All-American Canal is considered to be a main canal.

The approximate capacities of the other main canals, based on the available highest mean daily flows recorded during the study period, are:

East Highline Canal	2,700 cfs
Rositas Supply Canal	300 cfs
Vail Supply Canal	300 cfs
Vail Canal	300 cfs
Central Main Canal	1,300 cfs
Westside Main Canal	1,300 cfs

Smaller canals and laterals convey water from the main canals to virtually all of the water users.

3. Irrigation System Operations. The Imperial Unit is subdivided into the Brawley, Calipatria, Holtville, El Centro-Calexico, Imperial, and Westmorland Divisions. Water operations are managed in 50 smaller units known as "runs." Each division is composed of several runs. The term run refers to a specific area containing a portion of a main canal, a set of laterals, and customer turnouts.

In general, one hydrographer is responsible for a section of main canal. Where applicable, a hydrographer is also responsible for lateral operations assigned to a hydrographer run. A hydrographer may occasionally function as a zanjero (ditchrider) in an adjoining zanjero run.

Zanjeros are responsible for virtually all lateral operations and deliveries to customers on a small segment of the project consisting of several laterals. The runs operated by zanjeros are referred to as "zanjero runs." In general, one zanjero is assigned to a run. A number of zanjeros are assigned to each division office.

Water used within the District must travel from Parker Dam on the Colorado River downstream 148 miles to Imperial Dam. At Imperial Dam, the water is diverted through the headworks and desilting basins into the All-American Canal. The water then travels another 56.5 miles through the All-American Canal before reaching the East Highline Canal Turnout. Travel time from Parker Dam to Imperial Dam is about 60 hours. Travel time from Imperial Dam to the East Highline Canal Turnout requires another 6 hours. Travel time to the most distant customer requires an additional 18 hours. Water orders, therefore, must be estimated by the water department and transmitted to Parker Dam about 3 days in advance of anticipated grower needs.

Irrigation system operations are directed by the water department in coordination with the division offices located in Brawley, Calipatria, El Centro, Holtville, Imperial, and Westmorland. Irrigation operations are conducted on a continuous flow basis throughout the year.

The delivery of irrigation water to individual growers is based on a variation of a demand system rather than on a rotation, or "turn," system. Water orders are placed by the individual growers either with the water department or with a division office, as appropriate, at least 24 hours in advance of need. Water orders normally call for a fixed flowrate for a full 24-hour period. Each division office compiles the water orders by hand and transmits projected water requirements to the water department for analysis and coordination. Each division office then determines if the water allocated to it by the water department is adequate to meet its delivery requirements. If the water allocation is insufficient, some water orders must be delayed, or "carried over," to the following day. Respective growers, hydrographers, division offices, and zanjeros are informed of water delivery schedules by the water department.

The gates at Drop No. 1 are adjusted eleven times a day. Remaining gates on the All-American Canal are adjusted once a day. Lateral headgates are opened or reset at about 6 a.m. every day and are not normally adjusted again until the next day. However, minor adjustments are sometimes made during the intervening time period.

Due to changes in anticipated water needs, water arriving at Imperial Dam may be rejected by the District at Imperial Dam or at Pilot Knob Wasteway. When possible, the water order will be delivered to another water user or will be pumped into Senator Wash Reservoir and stored for future use. Senator Wash Reservoir has a maximum pumping capacity of only 1,000 cfs. Total storage capacity is 15,000 acre-feet. Water not delivered to another water user or pumped into Senator Wash Reservoir is bypassed to Mexico or passed through the main canals and discharged into the Sea.

The District functions as the water wholesaler and the divisions function as the water retailers. The water department and the six division offices maintain water distribution and delivery records. District Headquarters maintains all main canal flow records, except for the Westside Main Hydrographer Run which is operated by the Westmorland Division Office. The divisions maintain virtually all lateral flow records. Some flows are documented by both District Headquarters and the respective division office.

Each grower is responsible for the construction, operation, and maintenance of all irrigation features below his turnouts beginning at the edge of the District's right-of-way. These features include ditches, holding basins, field siphons, and other appurtenant structures.

4. Drainage System. As of December 31, 1981, the District operated and maintained 1,454 miles of surface drains and individual

growers had installed thousands of tailwater wasteboxes and 27,876 miles of tile drains.

Surface drains collect tailwater flows, tile drain flows, and canal and lateral wasteway flows. Most of these drains discharge their return flows into either the Alamo River or the New River, which then empty into the Sea. In addition, about 104,000 acre-feet of drainage water per year are discharged directly into the Sea by 34 surface drains.

Surface flows which run off the ends of the fields are referred to as tailwater. Tailwater flows are collected by wasteboxes and, in most cases, are discharged into surface drains through 12-inch pipes.

The District has been conducting an underground tile drainage program since 1929. As of December 31, 1981, 27,876 miles of tile drains had been installed on 427,587 acres of land. The individual farmer and the Soil Conservation Service of the Department of Agriculture jointly participate in the program.

Tile drains, buried in individual fields at depths ranging from 6 to 10 feet, control the shallow water table by drawing off excess deep percolation. Most of these drains are constructed of perforated plastic pipes in gravel envelopes and are connected to 8-inch transite collector pipes. Most of these drains discharge directly into surface drains, but a few discharge directly into either the Alamo River or the New River.

Good drainage has maintained a favorable salt balance since 1949 because more salt is being removed each year then is being contributed through the application of Colorado River water. Improved field drainage has caused soil productivity to increase throughout the Imperial Valley. The District plans to continue with the program.

The Alamo River enters the United States from Mexico and empties into the Sea. The river carries only about 4,000 acre-feet of water per year across the International Boundary, but acquires about 610,000 acre-feet of return flows in the United States to discharge about 614,000 acre-feet per year into the Sea.

The New River also enters the United States from Mexico and empties into the Sea. The river carries about 130,000 acre-feet of water per year across the International Boundary. Most of this water is sewage water from the city of Mexicali, Mexico. The river gains about 300,000 acre-feet of return flows in the United States to discharge a total of about 430,000 acre-feet per year into the Sea.

5. Municipal and Industrial Water Supplies. The District delivers about 25,000 acre-feet of Colorado River water each year to the cities and towns in the Imperial Valley for M&I consumption. The District is the water wholesaler and the cities and towns are the water retailers.

6. Power System. Development of the District's power system began in 1936. The power system services all of Imperial County except for the northeast corner; the extreme eastern portion of San Diego County; and the central portion of Riverside County, including the southern half of the Coachella Valley. The District met the electric power requirements of an estimated 119,000 people in the Imperial and Coachella Valleys in 1981.

Power system operations are directed by the power department at District headquarters in Imperial. District-owned and operated power generation facilities as of December 31, 1981, included the hydroelectric plants at Drops Nos. 2, 3, and 4 on the All-American Canal and at Pilot Knob Powerplant; the Double Weir and Turnip Canal low-head hydroelectric plants; the El Centro Steam Plant; the Brawley Diesel Plant; the four combustion turbine units at Coachella; and the two combustion turbine units at the Rockwood Plant near Brawley. The total District-owned nameplate rating was 440,750 kilowatts.

As of December 31, 1981, the District's electrical distribution system included over 4,000 miles of transmission and distribution lines.

In 1981, the District's Board of Directors (Board) established a policy to develop all feasible hydroelectric power generation sites on the irrigation system within the District. The sites identified as meeting sufficient drop and water flow requirements included Drops Nos. 1 and 5 and the East Highline Canal Turnout on the All-American Canal. A 4,000 kilowatt hydroelectric plant at Drop No. 5 went on line in 1982. The other two hydroelectric plants were scheduled for subsequent construction.

F. District-Implemented Water Conservation Efforts

1. Canal Lining. The concrete lining of District canals and laterals began in 1954. The District has been conducting a cooperative canal lining program since the 1960's. As of December 31, 1981, about 840 miles of canals and laterals had been lined. The District estimates that thousands of acre-feet of water are being saved each year. Program participation by the growers is voluntary. Each grower pays a percentage of the costs.

In general, only a short segment of a canal can be lined at any one time. Scheduling canal downtime in an area where crops are grown 12 months out of the year can be a problem. Maintenance requirements vary from canal to canal as does downtime. Routine maintenance usually requires a downtime of between 3 and 5 days. If a waterweed problem exists, maintenance is required more frequently.

In spite of these obstacles, both the District and the growers feel the benefits offered by the lining program are worth the required effort and expense. These benefits include improved response time of water deliveries, increased irrigable acreage, reduced operation and maintenance costs, reduced drainage problems in adjacent fields, and reduced repairs due to rodent activity. Even though the quantities of water saved have not been determined, the District plans to continue with the program.

2. Regulating Reservoirs. In order to improve conveyance system water regulation and operational flexibility and to reduce system spillage and excess flows to Mexico, the District initiated an ongoing program in 1975 to construct regulating reservoirs at suitable drop structures adjacent to main canals. As of December 31, 1982, the District had constructed four of these reservoirs. Each operates on the gravity-flow principle. The maximum storage capacity of each reservoir is about 500 acre-feet. By providing space to temporarily store excess flows for later release and use downstream, water levels in the conveyance system are stabilized and water is conserved.

3. Selective System Automation. The District has equipped a number of locations on the irrigation system with selected system automation features. A total of 23 locations have been fitted with gates remotely controlled at District Headquarters. Gates at an additional 17 locations have been fitted with automatic mechanical water level control devices. A number of other locations have been equipped with remote water level sensors that allow the water department to monitor flows at these locations. The water department uses a mobile radio system to dispatch hydrographers when manual gates require adjustment.

4. Canal Seepage Recovery System. About 36,000 acre-feet of seepage water are being collected by a canal seepage recovery system and returned to the irrigation system for reuse each year. This recovery system consists of a series of collector drains and sump pumps installed along parts of the All-American Canal beginning below Drop No. 1 and ending at the Central Main Check. A second series of collector drains and sump pumps has also been installed along parts of the East Highline Canal beginning at the East Highline Canal Turnout and ending at the Moss Lateral Turnout. The canal seepage recovery system also includes Sump Pump DP-13 which is located near the Dahlia Canal.

5. Actions of the Board of Directors. Every wooden water regulating structure on the irrigation system has been replaced by concrete within the past 30 years.

In 1976, the Board supplemented existing water conservation efforts by adopting a stringent 13-point program for water conservation. The goals of the program were to encourage to the fullest extent possible the beneficial use of available irrigation water supplies and the prevention of waste.

In 1979, the Board created a water conservation advisory board. The main objective of the advisory board is to investigate and formulate water conservation proposals for the Board's consideration. The advisory board is composed primarily of farmers.

In 1980, the Board supplemented the water conservation program by adopting an even more stringent 21-point program for water conservation proposed by the advisory board. The Board also approved a water rate increase in order to help fund the expanded water conservation program.

In 1981, a 2-year water management and conservation demonstration program, emphasizing the use of the neutron probe, was initiated in an effort to determine soil moisture content, and therefore, irrigation needs. A water conservation supervisor and three technicians were employed in order to implement and operate the program. In addition, the Board also increased the annual budget for the canal lining program and accelerated the construction of regulating reservoirs.